SCIENCE

FRIDAY, AUGUST 25, 1911

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE CALCULUS IN TECHNICAL LITERATURE

IT would be difficult to get a majority report on either the quantity or quality of the calculus used by practising engineers in any country even if their individual opinions on the matter could be obtained. Evidences of the many conflicting views likely to be held are presented in the testimony along this line contributed by former students of ours who, after a brief experience in the technical world, give us their impressions of how much they have been called upon in actual practise to use the various mathematical principles with which they wrestled so laboriously in freshman and sophomore college days.

Instructors of mathematics in universities where sections of engineering majors are formed have, no doubt, heard recited, as I have, the many and varied experiences of these young engineers with the problems involving mathematics which arose at various times in their brief experience. Perhaps some cub engineer, who already had done a piece or two of engineering work worth while, has told you of how he has never yet had to use his calculus and that he wonders why we keep on teaching it. Perhaps you have been told, as I have, that if the prospective engineers are thoroughly grounded in the differentiation and integration of u^n, and know what they mean and how to use them, they will then have as much calculus as they are likely to use in the problems which may arise. Again, you may have heard another say, as I have, that he is already using all the mathematics he ever learned—and then some—and that he wished he had taken various

other advanced courses in mathematics while in college.

The problems sent on by the young men in practise, and referred to you acting as a sort of consulting engineer, may vary, as I have experienced it, from those in which in the solutions sent an error was made in using the common logarithm of a number instead of the natural to those where the principles of the calculus involved were beyond what they had had time to study while in college. The problems were always live ones, definitely stated, and the solutions simply must be obtained—if not exactly then at least approximately correct. When they needed their calculus they needed it right away—of course they were going to get the result some way.

On the other hand, I have heard a professor of a technical subject in an engineering school of merit say in substance that perhaps, after all, calculus ought to be regarded as a culture subject; that it afforded good mental discipline, but that he doubted its value as a tool in engineering practise.

However much the opinions expressed may have varied, it has always seemed to me that the further a practising engineer advanced in his profession the more respect did he show for the elegant processes of not only the calculus but also of mathematics in general. These men may not themselves be called upon to work out the details of a design involving perhaps principles of the calculus, yet they will be competent in checking to pass on designs executed by others. They will also have a wide acquaintance with technical literature, especially that bearing on their special field.

When the mathematicians and engineers met in a joint conference at Chicago to investigate further the subject of mathematics for engineering students there seemed to be no question whatever as to the desirability of a thorough knowledge of the calculus, with the ability to use it, on the part of the engineer; the question simply was one of quantity, quality and efficiency in mastering the same.

The practising engineers, and I am speaking of those who have attained a position of at least average merit, keep in touch with modern developments not only in this country but in others as well, just as far as their knowledge of foreign languages will allow them to follow the literature. Assistants in large libraries will tell you that files of the current foreign technical papers, which may have been neglected entirely in undergraduate days, are later eagerly read by men of affairs who seemed to know what they were after.

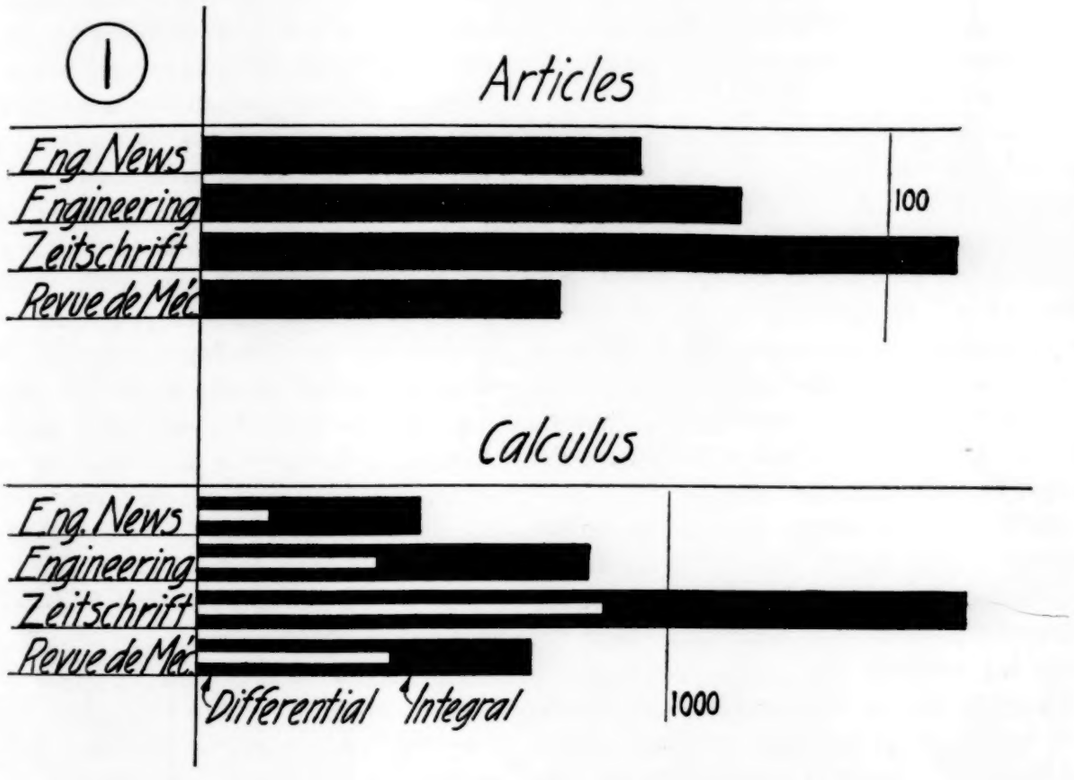
While not every advance in technical lines is reported in the journals, yet it would be safe to say that the most of those possessing merit receive recognition in publication, and that the files of a journal for a period of years are apt to reflect quite accurately the thoughts and deeds of engineers in the particular field covered by the journal in question. The aims and interests of engineers are clearly reflected—perhaps we may even get their attitude toward the calculus. And I would rather judge by what is done than what is said—an engineer early learns the value of results.

Different engineers will use and be interested in different fields of mathematics. Some editors of technical journals wouldn't care to publish an article heavy because of the mathematics used, and yet all use mathematics more or less—because they must. The question then arises as to the journal in any country chosen as the reflector of the opinions of engineers on the mathematics used and read during a period of years.

I have chosen the following journals as

representative in their respective countries: America, *Engineering News;* England, *Engineering;* Germany, *Zeitschrift des Vereins Ingenieur;* France, *Revue de Mécanique.* The first three papers are published weekly, the last monthly.

To get at the principles of the calculus used, and to what extent, I read the articles in the above journals making use of the principles of the calculus, published during the five years 1905–1909. The articles in which the calculus was used were listed and the results shown in Fig. 1. Many articles contained a species of "near calculus," thus making the question of including it or not doubtful; final disposition of the case was made on the basis of the article including at least one principle of the calculus and employing its nomenclature. The authors of the articles made use of the principles as needed, and understandingly. To read the articles intelligently a knowledge of the fundamental principles of the calculus was necessary—on this basis were the articles and principles listed.



The contributors of these articles included all classes of practising engineers, army officers, government officials, consulting engineers, whether connected with technical institutions or not, and professors in technical schools and universities. That the articles were read by engineers is evidenced by the numerous comments on the same sent in to the editors, as well as by the records of assistants in libraries specializing in files of technical papers.

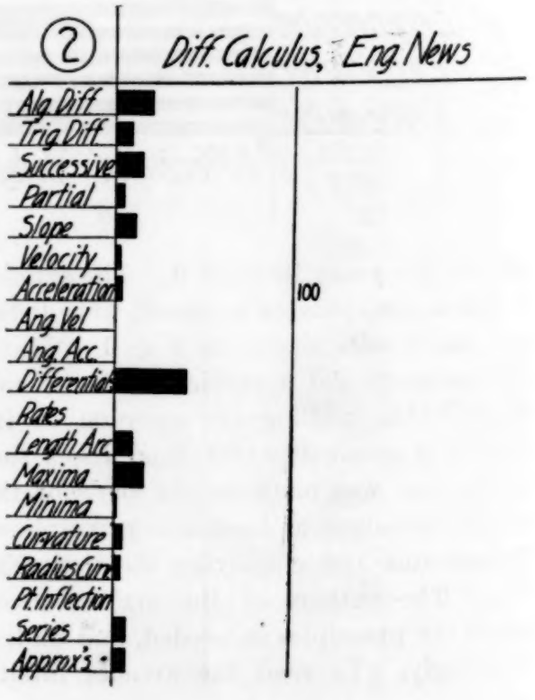
I do not use as a basis the opinions of men as expressed in the journals but rather investigated the principles actually used. The opinions of engineers, as expressed in the journals, were found to vary as much as the oral reports made by the young engineers formerly mentioned, and along this

line we find, quoting from the four journals chosen, such expressions as "formidable mathematics," "mathematical rubbish"; one writer apologizes for his "mathematical fireworks"; another says of a writer that he "enveloped elementary principles of engineering theory in such a haze as to render pursuit hopeless to any but a confirmed mathematician." Again, speaking of the work of young college graduates, one writer said: "All of them did calculating without checking as they proceeded," and "Accuracy is one of the keys to success."

From another paper we quote: "It is the pride of mathematicians to compress a great deal into a single formula. But a diet of tabloids, however full of nourishment, is not adapted to all digestions; and the present paper goes to the other extreme—namely, spoon-feeding." Again we quote: ". . . great respect for mathematical proofs—if experimental results don't support the theory so much the worse for experimental results."

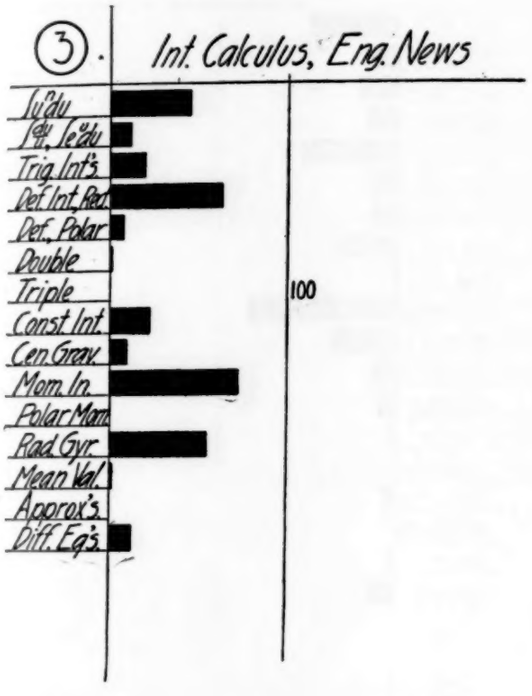
In a third journal we find a writer openly stating that he is writing his article so that the engineer knowing very little calculus, especially the integral, may yet read his article. Many other opinions expressed could be cited, and much discussion back and forth concerning proper methods of instruction in engineering mathematics abstracted with profit; yet it seems to me that, after all is said and the smoke of battle has cleared away, the engineers would, or should, rather be judged by what they do, and hence I present in the following table, I., a summary of the number of times which it seemed to me the calculus was used in each of the papers mentioned above during the period 1905–1909. The figure will explain itself when it is suggested that as far as a quantitative result is concerned I listed each principle of the differential and integral calculus as it was used in an article. It might easily be that, with a viewpoint different from the one used, that the table as made out by another might look entirely different from a quantitative standpoint, yet relatively the results could not differ materially. Different principles, as applied, might be listed numerically differently by two men working out the same problem. In listing these principles I counted a single one only once during a discussion, even though the same expression may have been used many times. However, when the same principle was used in a new form, or a new application made, it was again counted.

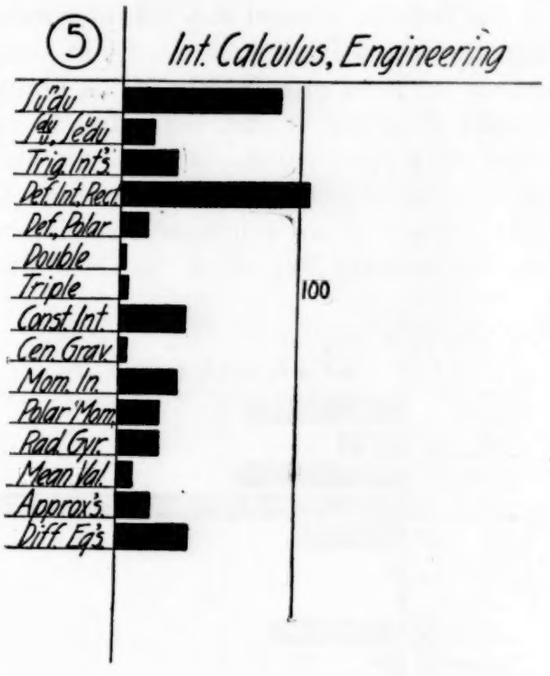
Regardless of opinions expressed in the journals and on the basis of the use made of the principles of the calculus in the years 1905–1909 we present Figs. 2 to 9 as giving the relative importance placed on these separate principles by the journals named. It may be said that each was used with the idea in mind that the reader was acquainted with all of them, and even

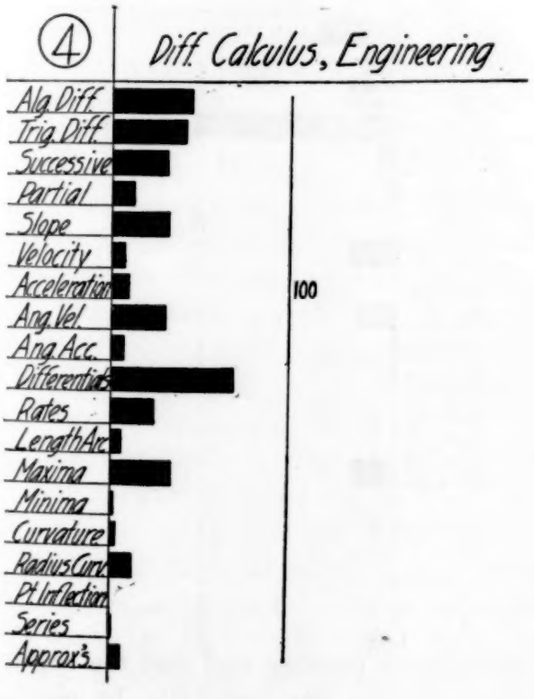


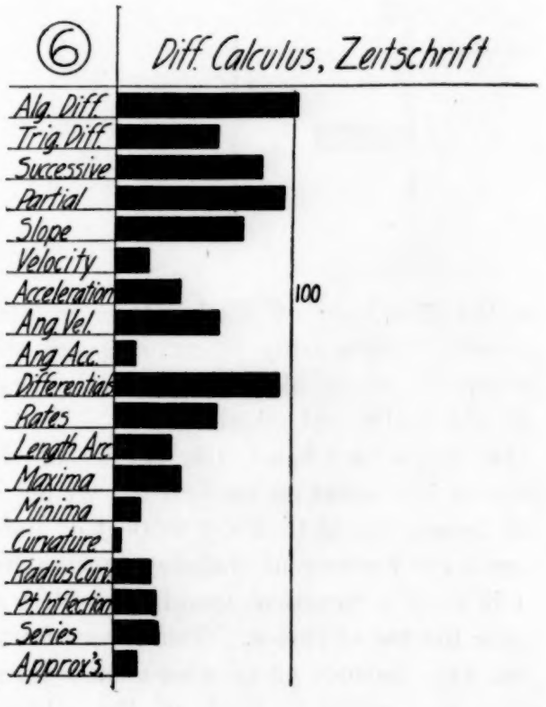
when an elliptic integral, a differential equation, or a Fourier series was used it was assumed that the reader was familiar with such.

The results as shown in the figures will, on comparison with similar figures accompanying an article in SCIENCE, October 22, 1909, in which a study of the calculus in

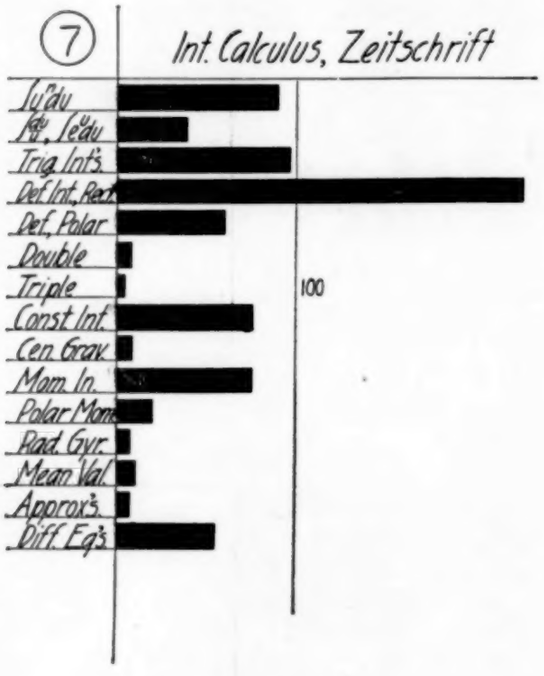






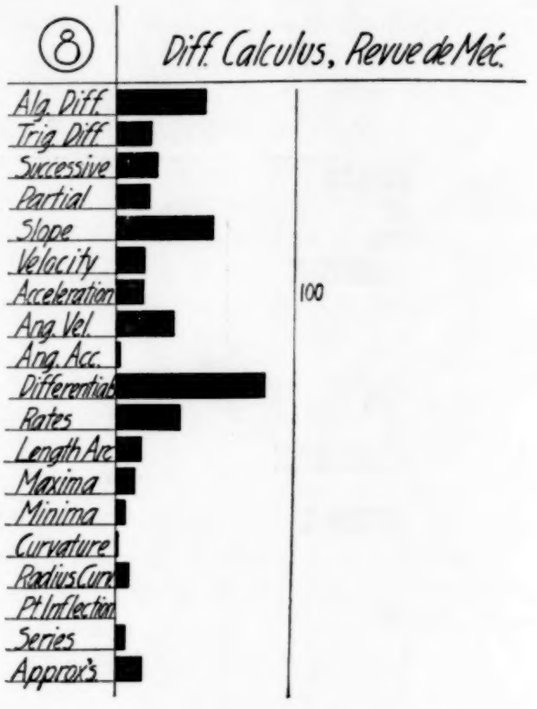


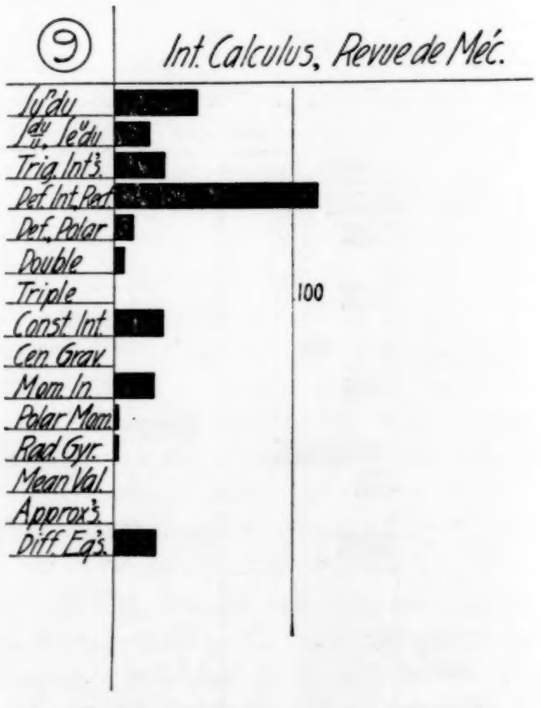
undergraduate technical courses was made, be found to agree closely with those published formerly in the relative emphasis placed on the various principles. Again we find that, for instance, the formulation of the definite integral and its interpretation by means of an area drawn to scale, stands out most prominently. This fundamental principle is just beginning to receive the recognition due it in the teaching of the calculus to engineering students, and deserves all the emphasis it receives in the Preliminary Report of the Committee



on the Teaching of Mathematics to Students of Engineering recently issued, and in several of the elementary texts on calculus recently published.

On the other hand, the results of the present investigation confirm the writer in his former belief that the subject of indeterminate forms and their evaluation has in it from a practical standpoint little of value for the engineer. There were found just two distinct cases where such forms arose and where methods of the calculus were used to evaluate the same. In view of the fact that such forms occur rarely in





engineering practise and that the required limit of each can generally be obtained

after transformation it is doubtful from the standpoint of the engineer if the subject is worth over a page of discussion in the report referred to above, or the many pages—in one case as many as 18—of recent elementary texts on the calculus. The time given to them in the course on calculus could be used to much better advantage elsewhere.

The relatively few times that the double and triple integrals are used agrees with the results in the undergraduate discussion. Double and triple integrals could be used more, but they aren't; engineers seem to prefer the single integral. From this we would not argue that they should receive attention in a course in the same ratio as they are found used in practise, for both have greater merit and occasions do arise in which they are fundamentally necessary and important.

The differentiations and integrations, as shown, are, for the most part, limited to a few types and are generally readily executed. The algebraic integrations do not at all resemble the heavy forms involving radicals and reduction formulas which were so painfully evident in the college course in calculus. The trigonometric forms, both in differentiation and integration, are limited almost entirely to sines and cosines and their combinations. The heavier integrations, both algebraic and trigonometric, are apt to occur in connection with the solution of the differential equations arising in the discussions.

Partial differentiation comes in for considerable attention partly because of the fact that the journals listed, especially the foreign, always seemed to welcome an article making use of the principles of thermodynamics. The relative importance of this portion of the calculus to the engineer seems to be greater than would be indicated by the amount of time given the subject in most of the courses in calculus for engineers.

The principles of angular velocity and acceleration are used with considerable frequency in the foreign journals, thus indicating clearly the strong influence of the mechanical engineering side of the technical field.

The attitude of all the journals in the matter of symbols is the same and agrees with the almost universal custom among mathematicians in this country. The somewhat forced efforts made for some time by certain mathematicians in this country to introduce capital letters in connection with derivatives seems to have received no recognition whatever among engineers.

Whenever a differential is used it has a strong resemblance to the infinitesimal of the mathematician, or perhaps a rate, where the time element comes in; but it will be noticed early that the processes of the engineer, by nature correct to, say, so many decimal places are not always the processes of the mathematician confirmed in his use of the limit. Increments sometimes take the place of these differentials and very neat bits of theory are carried out by their use—a "near calculus" as it were. It is at times difficult to distinguish between the use of Δx and dx and yet the idea of the limit is there all the time. Rigor within the limit of allowable error is the key-note throughout. As an illustration I quote: "Let the radii of curvature of the surfaces where the oil film is infinitely thin be r_1 and r_2; then, since we are dealing with films of capillary thickness, we may treat the dimensions as infinitesimals as compared with r_1 and r_2." With which many a pure mathematician will find it difficult to agree. And yet the proofs do not break down at any point.

More maxima and minima are found directly from the study of algebraic and

trigonometric expressions than by the methods of the calculus, and but little attention is paid to the sign of the second derivative in determining the nature of the same. The conditions of the problem are, in general, sufficient to determine the nature of the result on solving the equation obtained by putting $dy/dx = 0$.

Series where used are assumed to be convergent, or at least their convergence is not questioned. They are generally simple types.

Many approximations occur in engineering practise, while those listed seem to be few in number. However, none was counted except the approximations of the calculus. Among such we might mention $1/r = d^2y/dx^2$, which is used in a case where, as stated, "dy/dx is small."

The symbol of summation Σ is used often and we find many a case of "near integration." The great importance placed on the formulation and evaluation of the definite integral is everywhere evident and many areas are found where no definite integral is expressed and where it is absolutely essential to keep in mind the relation between the two. In this connection we wish to mention the universal use of indicator diagrams, and the frequent mention of the planimeter used in determining areas approximately—a point of view which should be kept in mind when the subject of definite integrals is being considered in the class-room.

In connection with the integrations found it seemed that at times the constants multiplying the integral were by far the most important part of the expression. Instructors of calculus might with profit at times allow their students to make their own choice of such constants, which should be placed on the outside of the integral sign before evaluating the definite integral. The term moment of inertia seems to mean two things to two different classes of engineers. The engineer dealing with static problems will have almost exclusively to do with moments of inertia of sections, while one working with problems bringing in dynamics will think of what in one case is called the "equatorial moment." The two points of view should receive equal attention in any course on the calculus.

Concerning the differential equations used and their solutions it may be said that those used were of the simpler types usually included in an elementary treatise on ordinary differential equations. However, it seems to me that their solutions must at times have been far above the head of the average engineer, unless he had given the subject special attention after completing his university course in engineering. The recommendation of the committee on engineering mathematics is to the point, and should be carefully considered by the instructor of calculus. It agrees with results as found in practise.

A further study of the mathematics used by the practising engineer will reveal other conditions in every way similar to those existing in the undergraduate technical course. The algebra and trigonometry used are heavy as compared with the calculus; naturally they are used much oftener.

If we look for things characteristic of the engineer we easily find that numerical results, correct to a certain decimal place, are common and that much stress is placed on accurate computation. Much care is bestowed on the drawings and illustrations, and constant attention is given to the scale of the same. This is necessary in checking up. Much use is made of indicator diagrams and the planimeter is used to obtain or check up on areas. At least one of the journals makes a considerable use of the first and second derivative curves and

their interpretation. The policy of the *Zeitschrift* in using such curves is to be recommended to the instructor when the subjects of velocities and accelerations are under consideration.

A common practise in approximating is that of using small angles, their sines, and tangents synonymously.

The checking up process stands out prominently; not only do the engineers say they believe in it but they also practise it as well. Instructors of mathematics may easily learn a lesson here.

The definite character of the results is evident; the authors get down to fundamental principles, remain clear throughout a discussion, and finish with concrete results.

Here and there is found an article on a special subject which will tax the mathematical capacity of most engineers, perhaps be far above their heads. Such are generally contributed by professors in universities and mark the limit of the mathematical field for engineers. We find a rare use of an elliptic integral, a Fourier series, homogeneous coordinates, partial differential equations, and the fundamental principles of the calculus of variation. However, these are rare and the articles using such will be read by but a very limited number of engineers.

A comparison of the articles in the different journals will show for the American the strong preponderance of the civil engineering, while the foreign journals lean more to the mechanical engineering side. In none of them do the articles go into the details of the projects in electrical engineering. The articles in this latter field are mostly of a descriptive nature, in which electric power installations, machines and appliances are discussed. Whenever mathematics is used in the electrical engineering field it verges on the more "formidable" mathematics of mathematical physics, combined with a liberal sprinkling of the complex variable and differential equations. The list examined can hardly be said to contain a journal specializing in the field of electrical engineering. However, if the stronger journals in the electrical field be examined they will be found to strongly emphasize the descriptive features of the field; and a conclusion which may be drawn from this fact is that even the rudiments of research and design in that field would immediately involve mathematics in the principles of which the average engineering major has had but little training. Articles going into these details would not be read as the more general articles in the other fields of engineering are read.

The technical literature also reflects the highly developed scientific spirit of Germany, which has permeated into all the branches of its technology. The continental journals, especially the German, start with fundamental engineering principles and make a liberal use of the calculus and other branches of mathematics; so that when a discussion is completed it is evident that a piece of work worth while has been thoroughly done. On the other hand, the American attitude of wanting to get things done in short order is also plainly evident; the American engineer will generally not take the time to work out a bit of theory in the details of which the German engineer will revel. He will use—and with a full significance of their purpose—the results laboriously obtained by others, thus specializing on the applications. A formula developed with much care from fundamental principles by his foreign brother will appeal to an American engineer as something which should immediately be put to practical use.

The English journals take as much pride in the design of their battleships and ves-

sels of commerce as the Germans and French in their air-ships and the Americans in their sky-scrapers. And all are interested in turbines. The *Zeitschrift* seems to be by far the greatest source of scientific advances in technology, and the engineering journals of other nations look to it as the dean of them all.

A study of this sort would not be complete unless it took into consideration the far-reaching effect which the failure of the Quebec bridge, on August 29, 1907, had on technical literature, especially in America. In the many discussions of column formulas resulting, with special reference to the value of l/r found in most of them, we can easily see the strong inclination of the American engineer toward a plausible formula. Many discussions followed the disaster, most of them making use of l/r and suggesting modifications of the column formulas in existence. It may be questioned, in view of the results of recent tests made on built-up columns, whether the old formulas, even with modifications, will not be superseded by some entirely new rules for the design of such columns.

It may be stated, in conclusion, that the attitude of the engineers toward the efficient teaching of the principles of mathematics, as gathered from their discussions, is sane and their interest great. Naturally, they call for results and are apt to be impatient if a college graduate violates fundamental principles which should have been thoroughly mastered long before. They are aware of the difficulties encountered in the efficient teaching of mathematics and of the different viewpoints of instructors of mathematics. On the other hand, instructors of mathematics for students of engineering should maintain an attitude of sympathy with the problems of the engineer, or at least recognize and become acquainted with them. That both engineers and mathematicians are working more and more toward a common end, and with a better understanding of the problems involved, is evidenced by the results of the many joint conferences held recently for the purpose of securing that greater efficiency, which is the watchword of the age.

Ernest W. Ponzer
Stanford University

RICHARD KLEBS

Professor Dr. Richard Klebs, geologist and knight of high degree, connected with the Royal Geological Survey, and scientific adviser to the Royal Amber Works, died in Konigsberg, Prussia, on June 20, 1911, in his sixty-seventh year.

Dr. Klebs was well known throughout the world for many papers on the subject of amber and its industry, the inclusions and the study of the coleoptera, and plant and insect inclusions in amber masses, he himself gathering and owning the great collection which was exhibited under the auspices of the Imperial German government at the St. Louis Exposition in 1904. This great collection consists of 10,000 inclusions in amber, including beetles, fleas, spiders, wood, leaves and many other interesting objects associated with the history of amber. It is valued at $40,000 and will only be sold as an entirety.

The last paper he wrote, and of which he sent me a reprint, is entitled: "Ueber Bernsteineinschlusse im allgemeinen und die Coleopteren meiner Bernsteinsammlung," with text illustrations, which appeared in the "Schriften der Physik.-okonom. Gesellschaft zu Konigsberg i Pr." Jahr. LI., pp. 217–242, III., 1910. Dr. Alfons Dampf, assistant in the Konigl. Zoologischen Museum, Konigsberg, described a fossil flea occurring in Baltic amber and named it "Palæopsylla klebsiana," in honor of his friend, Dr. Klebs (pp. 248–259, pl. 2, 1910–11).

Dr. Klebs possessed an earnest, cheerful personality; was an indefatigable worker, published many papers on his subject, and suc-

ceeded to a far greater extent than any one else interested in attracting notice to the great amber industry, which the German government is now paternally fostering with much satisfaction to all and with considerable financial success. He leaves a wife, a brother and grandchildren—one a son-in-law of Dr. Carl Kaiserling, of the University of Berlin.

GEORGE F. KUNZ

THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS

ANNOUNCEMENT is made by Dr. H. W. Wiley, secretary of the Association of Official Agricultural Chemists, that the twenty-eighth annual convention of the association will be held at Washington, D. C., from November 20 to 22. The program is as follows:

MONDAY, NOVEMBER 20

MORNING SESSION

Phosphoric Acid: H. D. Haskins, Amherst, Mass.
Determination of Nitrogen: J. W. Kellogg, Harrisburg, Pa.
Potash—
Determination: E. L. Baker, Geneva, N. Y.
Availability: H. H. Hill, Blacksburg, Va.
Soils: J. G. Lipman, New Brunswick, N. J.
Inorganic Plant Constituents: O. M. Shedd, Lexington, Ky.

AFTERNOON SESSION

Appointment of Committees

Insecticides: C. C. McDonnell, Washington, D. C.
Water: W. W. Skinner, Washington, D. C.
Committee A on Recommendations of Referees: J. P. Street, New Haven, Conn.

Reports of Special Committees

Amendments to the Constitution: L. L. Van Slyke, Geneva, N. Y.
Appropriation: J. P. Street, New Haven, Conn.
Availability of Phosphoric Acid in Basic Slag: W. F. Hand, Agricultural College, Miss.
Cooperation with other Agricultural Organizations: H. W. Wiley, Washington, D. C.
Food Standards: William Frear, State College, Pa.
Journal of Agricultural Research: W. A. Withers, Raleigh, N. C.
Participation in the Eighth International Congress of Applied Chemistry: J. P. Street, New Haven, Conn.
Presentation of the Question of Unification of Terms to the International Congress of Applied Chemistry: R. J. Davidson, Blacksburg, Va.
Standardization of Alcohol Tables: L. M. Tolman, Washington, D. C.
Testing of Chemical Reagents: L. F. Kebler: Washington, D. C.
Unification of Methods of Analysis of Fats and Oils: L. M. Tolman, Washington, D. C.

TUESDAY, NOVEMBER 21

MORNING SESSION

Food Adulteration: A. S. Mitchell, St. Paul, Minn.
Colors: W. E. Mathewson, New York City.
Saccharine Products: S. H. Ross, Omaha, Neb.
Fruit Products: A. W. Blair, Gainesville, Fla.
Wine: E. J. Lea, Berkeley, Cal.
Beer: W. D. McAbee, Indianapolis, Ind.
Distilled Liquors: J. O. LaBach, Lexington, Ky.
Vinegar: W. A. Bender, New York City.
Flavoring Extracts: R. S. Hiltner, Denver, Colo.
Spices: R. W. Hilts, Philadelphia, Pa.
Baking Powder: E. W. Magruder, Richmond, Va.
Meat and Fish: Ralph Hoagland, St. Anthony Park, St. Paul, Minn.
Fats and Oils: H. S. Bailey, Washington, D. C.
Dairy Products: A. E. Paul, Chicago, Ill.
Cereal Products: H. L. White, Agricultural College, N. D.
Vegetables: J. P. Street, New Haven, Conn.
Condiments other than Spices: W J McGee, New Orleans, La.
Cocoa and Cocoa Products: W. L. Dubois, Buffalo, N. Y.
Tea and Coffee: M. E. Jaffa, Berkeley, Cal.
Preservatives: H. E. Barnard, Indianapolis, Ind.
Water in Foods: H. C. Lythgoe, Boston, Mass.
Organic and Inorganic Phosphorus in Foods: H. S. Grindley, Urbana, Ill.
President's Address (special order for 12 o'clock).

AFTERNOON SESSION

Separation of Nitrogenous Bodies—
Meat Proteids: C. R. Moulton, Columbia, Mo.
Milk and Cheese: A. W. Bosworth, Geneva, N. Y.
Vegetable Proteids: R. Harcourt, Guelph, Canada.
Committee C on Recommendations of Referees: A. L. Winton, Chicago, Ill.

WEDNESDAY, NOVEMBER 22

MORNING SESSION

Dairy Products: G. W. Cavanaugh, Ithaca, N. Y.
Foods and Feeding Stuffs: G. M. MacNider, Raleigh, N. C.
Sugar: W. E. Cross, New Orleans, La.
Committee B on Recommendations of Referees: E. M. Chace, Washington, D. C.
Reports of Committees (resolutions, nominations, etc.): J. S. Rogers, Washington, D. C.

AFTERNOON SESSION

Medicinal Plants and Drugs: L. F. Kebler, Washington, D. C.
Medicinal Plants: Albert Schneider, San Francisco, Cal., and H. H. Rusby, New York City.
Synthetic Products: W. O. Emery, Washington, D. C.
Medicated Soft Drinks: H. C. Fuller, Washington, D. C.

Special papers closely connected with the work of the association, and not exceeding 10 minutes in length, will be given place on the program if the titles are sent to the secretary ten days before the meeting.

SCIENTIFIC NOTES AND NEWS

DR. GILMAN A. DREW, since 1900 professor of biology at the University of Maine, and since 1909 assistant director of the Marine Biological Laboratory, has been appointed resident assistant director of the laboratory, and will devote his entire time to the work at Woods Hole.

IN the Geodetic Institute of Potsdam, Professor Andreas Galle has been appointed chief of department, and Dr. Wilhelm Schweydar, observer.

THE fifteenth anniversary of the doctorate of Dr. Wilhelm Waldeyer was celebrated on July 22. The Prussian minister of education and the Prussian war office presented him with gold medals, Dr. Hans Virchow with a Festschrift, and Dr. Paul Ehrlich with a volume of his own.

DR. WOLDEMAR VOIGT, professor of physics at Göttingen, has been elected a member of the Paris Academy of Sciences.

THE first award of the Dr. Jessie Macgregor memorial prize has been made to Agnes Ellen Porter, M.D. Edin. The prize has been awarded to Dr. Porter for work done in the last three years, mainly in the departments of bacteriology and physiology, and especially for her work on the precipitative reaction in tuberculosis.

PRESIDENT TAFT, Mr. John Hays Hammond, Mr. James J. Hill and Mr. Walter Fisher, secretary of the interior, will be the principal speakers at the annual meeting of the American Mining Congress, to be held in Chicago on September 26, 27, 28 and 29.

THE Carnegie Peace Foundation Conference was opened at Berne on August 2 under the presidency of Professor Clark, of Columbia University.

PROFESSOR L. R. JONES, of the College of Agriculture of the University of Wisconsin, is engaged in the study of a new disease which affects the pea crop of this state and of a kind of black rot which attacks the cabbages.

PROFESSOR A. S. HITCHCOCK, systematic agrostologist, U. S. Department of Agriculture, has gone to Panama to join the Smithsonian expedition for the biological survey of the Panama Canal Zone. He has also been authorized by the Department of Agriculture to visit the five Central American Republics, for the purpose of investigating the grasses. He is accompanied by his son, Frank H. Hitchcock, as assistant.

PROFESSOR FRANKLIN H. KING, who was born in Wisconsin in 1848, died in his home at Madison, Wis., of heart failure, on August 4, aged sixty-three years. He was well known for his publications on agriculture, especially in connection with agricultural physics and the soil. Professor King was just about to publish a new work "Farms of Forty Centuries," containing an account of Chinese and Japanese farming as observed by him during a recent sojourn in the Orient. He was ably assisted by his cultured wife in the preparation of his publications, and she will doubtless be able to complete the editorial work on the forthcoming volume.

M. ERNEST MERCADIER, formerly professor of physics at the Ecole Superiéure de Télégraphic

and director of studies at the Ecole Polytechnique, Paris, died on July 27, in his seventy-sixth year.

A NEW YORK state civil service examination on September 16 will select men for the position of inspector of weights and measures and inspector of cold storage plants at salaries of $1,200.

PRESIDENT TAFT has issued a proclamation setting aside as a national monument about 800 acres within the Sierra National Forest, known as the Devil Post-pile and Rainbow Falls.

WE learn from *Nature* that among the bequests of M. Marino Corgialegno, a naturalized British subject, who died on April 26, are: £40,000 to institute a school at Athens on the lines of Eton or Harrow, "sharing in the desire expressed to me by his Majesty King George that education in Greece should be rendered more perfect by the establishment of a public or secondary school upon the model of the English public schools, where boys will receive a regular course of teaching as well as of good breeding"; £40,000 for a school for craftsmen at Argostoli, in the island of Cephalonia; £15,000 for technical scholarships; £10,000 each for a school for girls in Cephalonia, for schools or gymnasia in Argostoli, for a public library at Argostoli, for the Agricultural Society at Athens, for a polyclinical hospital in Athens, and for the Society for the Propagation of Useful Books.

THE summer meeting of the Institution of Mechanical Engineers was held at Zurich and northern Switzerland, commencing on July 24. In addition to the meetings for the reading of papers, an extensive program of visits to works and hydro-electric power stations was arranged.

THE fifth annual meeting of the Italian Society for the Advancement of Science, as we learn from *Nature,* will be held in Rome on October 12–18, under the presidency of Professor G. Ciamician. The sections of the association, with their presidents, are as follows: mathematics, astronomy and geodesy, Professor G. Castelnuovo and Professor A. Di Legge; physics, Professor P. Blaserna; applied mechanics and electrotechnics, Professor C. Ceradini; pure and applied chemistry, Professor E. Paternò; mineralogy and geology, Professor R. Meli; geography, Professor E. Millosevich; zoology, anatomy and anthropology, Professors G. B. Grassi, F. Todaro and G. Sergi; pure and applied botany, Professor R. Pirotta; physiology, Professor L. Luciani; pathology, Professors A. Bignami and E. Marchiafava; history and archeology, Professors G. Beloch and L. Pigorini; philology, Professor I. Guidi; social science, Professor M. Pantaleoni; philosophy, Professor P. Ragnisco. Several lectures on subjects of wide scientific interest will be delivered to general meetings of the association as a whole, and others to joint meetings of sections concerned with related subjects.

THE report of the Pasteur Institute at Paris for the year 1910, which has recently been issued and is summarized in the *British Medical Journal,* shows a continuous decrease in the number of cases of rabies occurring or treated in France. In the year 1886 the number of persons bitten by rabid animals and treated at the Pasteur Institute was 2,671, and of these cases 25 were fatal, probably because treatment was too long delayed. In 1896 the number of patients treated had fallen to 1,308, with 4 fatal cases. Each subsequent year showed a steady decline in the number of cases of rabies, which numbered about 1,000 in 1902. In 1908 and 1909 the number of cases had fallen to 524 and 467 respectively, with 1 fatal case in each year; in 1910 the cases treated numbered 401, and for the first time since its foundation the Pasteur Institute was able to show a clean bill of mortality.

THE United States and Canadian contributors to the eleventh edition of the Encyclopædia Britannica, presented to Hugh Chisholm, Esq., editor of the eleventh edition, a loving cup, properly inscribed, and on receiving it he writes as follows: "It will long be a matter of pride to myself and family to possess this memorial of American appreciation of my share in directing the cooperation of American scholars, men of letters, men of science and technologists in various departments,

in carrying out the ideal policy which was arrived at in planning the eleventh edition of the Encyclopædia Britannica, namely a combination of forces between the two great branches of the English speaking world. In the intellectual sphere it stands as a notable achievement of Anglo-American unity with which I am proud to have been associated. I thank the American contributors for their more than kind recognition of my labors towards that end."

A new research hospital, in which the committee for the study of special diseases will continue their researches on rheumatoid arthritis and allied diseases, is now in course of erection at Cambridge. The site, which has been presented by Miss Sykes at a cost of £300, has a southeast slope, with gravel soil, and the building has been designed with a view to simplicity and economy. As at present arranged provision is made for eight or nine patients, but should more accommodation be required double that number could be admitted. The funds available for the building now amount to a little over £1,000, and there is a sum of £800 still required in order to open the building free from debt. Dr. R. C. Brown, of Preston, who for the last four years has given a research scholarship of £150 a year, has during the past week signified his intention of continuing the scholarship for a further term of two years. The committee is at present making efforts to raise the remaining £800 required to complete the building and is also asking for subscriptions towards an endowment fund of £8,000. The executive committee are Sir Clifford Allbutt, regius professor of physic, Cambridge; Sir W. Selby Church, late president of the Royal College of Physicians; Sir William Osler, regius professor of physic, Oxford; Mr. T. S. P. Strangeways, Huddersfield lecturer in special pathology, Cambridge, and Professor Woodhead, professor of pathology, Cambridge.

The first provisional announcement of the new course for public health officers, which is to be given for the first time during the coming year at the University of Wisconsin, has just been made. This course will be open to those who hold a degree in medicine or in medical or sanitary science and desire to fit themselves for public health work. The course extends through one year and leads to a diploma in public health. The work of the course is devoted largely to a study of bacteriology and practical field work in the use of disinfectants, the inspection of slaughter houses, schools, factories and work shops. Additional courses in physiology, zoology, meteorology, hydrology, public health administration and vital statistics, and the microscopic examination of foods and drugs will comprise the remainder of the work. The course in meteorology, or the study of weather conditions, is given for the purpose of determining to what extent the weather affects public health.

UNIVERSITY AND EDUCATIONAL NEWS

Work is now being carried on to arrange and equip an entomology building at Rutgers College, New Brunswick, N. J. The building will have two stories, will provide for classrooms and laboratory work on the first floor and will furnish offices and space for collections on the second floor as well as accommodations for the assistants in experiment station work.

Real estate belonging to the Massachusetts Agricultural College to the value of $850,000 has been transferred to the state of Massachusetts in a deed recorded in Northampton. By this transfer the land and buildings of the college heretofore vested in the incorporated board of trustees passes under the direct control of the state.

The Missouri College of Agriculture and Experiment Station is to have a regularly organized poultry department, the purpose of which is to investigate the various diseases and pests that affect farm fowls, to study the relative utility of different breeds of poultry for various localities of the state, to experiment with the problem of feeding poultry for breeding purposes and for market, besides giving regular courses of instruction in poultry husbandry to students.

Official reports of the universities in Switzerland note that for the half year just finished, there were 10,311 students of which

1,322 were at the School of Technology. Of the 6,862 regular students of the seven universities, 1,490 were women. There were 459 in the department of theology, 1,354 in the law, 1,980 in medicine and 3,069 in letters or in sciences. The foreign element furnished 52.5 per cent. of the whole.

ALL the graduate work offered at the Ohio State University has been organized into a single graduate school under the administration of a dean and a graduate council of twelve members. Professor William McPherson, in charge of the department of chemistry, has been elected dean.

AT the Missouri College of Agriculture appointments have been made as follows: J. A. Ferguson, professor of forestry; A. J. Meyer, assistant to the dean and superintendent of short courses in agriculture; H. L. Kempster, assistant professor of poultry husbandry, and P. L. Gainey, instructor in botany.

PROFESSOR WILLIAM HAZEN BOUGHTON, head of the department of civil engineering in the University of West Virginia, has resigned to accept the position of treasurer and general manager of Vassar College.

DR. NICOLAS LEON has been named professor of anthropology at the Museo Nacional, Mexico.

MR. HUGH GUNN, formerly director of education of the Orange Free State, has accepted an invitation from the government of Western Australia to act as adviser and organizer for the university which that state is founding at Perth.

DR. KARL DIEWONSKI, a manufacturing chemist, has been appointed professor of chemistry in the University of Cracow.

DISCUSSION AND CORRESPONDENCE

AIR IN THE DEPTHS OF THE OCEAN

TO THE EDITOR OF SCIENCE: The question has often been asked, how does the air, which is assumed to be necessary for the life of deep-sea fishes, get to those depths. Possibly a satisfactory explanation exists, if not, the following suggested itself to me as a plausible one, and possibly as a new one.

It is well known that the amount of gas which a liquid will hold in clear and stable solution, increases with the pressure. The liquid in a bottle of champagne or in a siphon bottle, for instance, is clear until the pressure is released. It may be assumed that the water on the top surface of the ocean is being continuously saturated with air due to the spraying of the waves. The layer beneath is at a slightly higher pressure, hence will hold more air per unit volume, than the one above it. Under such circumstances it seems that there should be a tendency for the air in the top layer to move down to the less saturated one beneath it, until it too is saturated, and this will require a larger amount of air per unit volume. The same is true of the next lower layer, and so on to the bottom.

It would seem to follow, therefore, that air actually descends into the ocean depths, and if it is being consumed there for oxidation and nitrification purposes, there should be a continuous flow of air downward into the deepest ocean waters. If oxygen dissolves in sea water more freely than nitrogen, the deep-sea fishes should be enjoying richer air and therefore should require less of it, than those living nearer to the surface.

CARL HERING

PHILADELPHIA, PA.,
July 31, 1911

THE LIGHTING OF A JET OF HYDROGEN

TO THE EDITOR OF SCIENCE: I have examined perhaps a dozen laboratory manuals for beginners in chemistry with reference to the experiment in which the student is required to light a jet of hydrogen and in every case the directions are essentially the same: wait till the air is all expelled, as indicated by the failure to get an explosion when a test-tube full of the escaping gas is brought over a flame, securely wrap a towel around the generating flask, and bring a light to the exit. Now these directions will certainly result in occasional explosions of the contents of the flask, especially if the laboratory sections are large, with possible serious consequences. The careful student, having been cautioned as to the danger of the experiment, will often wait an undue length of time and will still be nervous about bringing a flame to

the exit; while the less careful worker is likely to attempt to light the gas prematurely.

All possibility of an explosion is removed by a very simple procedure, which is doubtless widely used, but which has not found its way into the manuals. When the air has been completely expelled, the hydrogen will burn tranquilly in the test-tube. The test-tube, containing the burning hydrogen, is, by a quick movement, brought over the escaping hydrogen. One or two trials will be sufficient to ignite the jet. The towel may be dispensed with.

Neither originality nor novelty is claimed for this suggestion. This note is written merely with the hope that some one of the numerous writers of manuals will revise the directions for this particular exercise and discard the time-honored towel.

B. F. Lovelace

University of Alabama,
May 25, 1911

QUOTATIONS

The Administration of the Department of Agriculture

With the testimony yesterday of Dr. Wiley himself, the Moss committee concluded its hearings. President Taft will next be heard from. But conditions have changed since Attorney General Wickersham, after reading a cooked-up case, declared that Dr. Wiley and his associates in guarding the foods and medicines of the people merited "condign punishment." Like thunderbolt the illuminating publication that exposed the doings of the McCabe cabal in the Department of Agriculture must have seemed to Solicitor McCabe and his fellow-conspirators just as they thought their secret charges against the Chief Chemist were accomplishing his ruin. The public now knows that the Food and Drugs Act has been officially disregarded; that scores of important cases against alleged adulterators and misbranders have been deliberately held in abeyance; that department officials did not hesitate to garble the terms of court findings, and that an organized effort was being made, by the cutting down of salaries and "star chamber" proceedings, to drive honest public servants out of the Bureau of Chemistry. It is not imprudent to predict that if, in his decision, President Taft recommends "condign punishment," the recommendation will not be directed against Dr. Wiley and Dr. Rusby.—*The New York Times.*

It is not too much to say that Dr. Wiley, in his first day's testimony before the House committee, absolutely riddled the case against him. The so-called documentary evidence upon which Attorney-General Wickersham so gravely passed, was no evidence at all. Its chief piece was a letter to Dr. Wiley, but it now appears that it was never sent to him nor received by him. He had nothing whatever to do with making the contract with Dr. Rusby, for which offence his resignation was demanded. The whole thing was to be "subject to the approval of the Department"—that is, the Secretary—though these words were omitted by the personnel board when it published a copy of Dr. Rusby's letter. It is evident that the Attorney-General was grievously misled; he ought to make haste to recall his opinion and to apologize to Dr. Wiley. As for the schemers against Dr. Wiley, the investigation has left them in a most unenviable plight. Their stay in the public service ought to be of the briefest. And the inquiry has, it must also be said, shown such an unhappy state of affairs within the Department of Agriculture, which appears to be honeycombed with intrigue and faction, and badly suffering for lack of firm, executive control, as to indicate the need of its reorganization from the top down.—*The N. Y. Evening Post.*

SCIENTIFIC BOOKS

Mendelism. By R. C. Punnett. Third edition, entirely rewritten and much enlarged. Pp. 192, 5 plates and 35 text-figures. New York, The Macmillan Co. 1911. Price $1.25.

Punnett has shown that a scientific book need not be dull. His new treatise on "Mendelism" is a thorough exposition of a difficult and technical subject, yet it is as entertaining

as a novel. It deals with the new science of genetics, "the experimental study of heredity and variation in animals and plants," and contains the clearest and best account of its rise and present condition that has yet been published in any language. It lacks the encyclopedic completeness and the bibliographic features of the work of Bateson and Przibram, and will of course need to be supplemented by them in the hands of the advanced student, but for the beginner or the general reader who wants within moderate compass a sane and well-balanced account of what has been accomplished in this field, the book is almost ideal.

It does not pretend to give an account of all the work done in this field, but of only so much of it as will serve adequately to illustrate the principles involved. The author writes in his preface:

> In choosing typical examples to illustrate the growth of our ideas it was natural that I should give the preference to those with which I was most familiar. For this reason the book is in some measure a record of the work accomplished by the Cambridge School of Genetics, and it is not unfair to say that under the leadership of William Bateson the contributions of this school have been second to none. But it should not be forgotten that workers in other European countries, and especially in America, have amassed a large and valuable body of evidence with which it is impossible to deal in a small volume of this scope.

The illustrative material, however, has been remarkably well selected, and the wide range of questions upon which it bears speaks eloquently of the industry of the workers in "the Cambridge School" and their clear vision of what are the vital problems in genetics. Needless to say this book is an exposition of *orthodox* "Mendelism." Gametes are treated as beyond suspicion "pure," and unit-characters are regarded as immutable. Variation is supposed to occur only by loss of factors, or by the interpolation of new, "modifying," "intensifying" or "inhibiting" factors, but never by a direct change in the factors that before existed. There are Mendelians who are heterodox or at least have inner questionings about some of these assumptions, and are likely to challenge them in the next ten years as they have in the last ten. But the author has wisely omitted controversial points from a general and introductory account of his subject. His account shows that a really great advance has been made in the study of evolution since the rediscovery of Mendel's law and the readoption of the experimental method of studying variation and heredity.

The book opens with a brief statement of "the problem," of the source of new individuals in the gametes, and their part in the life-cycle. This is followed by a likewise brief but well-proportioned historical account of Mendel's work and of that of his predecessors, as well as of the Darwinian period following Mendel's time. The essential points in Mendel's work are shown to be the existence of unit-characters and their segregation, dominance being an incidental matter. The rest of the book is concerned largely with the development of Mendelian ideas since the rediscovery of Mendel's law in 1900.

The "presence and absence" theory is built up with great skill and clearness from an analysis of the inheritance of comb-form in fowls. This theory has all but replaced the earlier idea of Mendel, that the recessive character is something no less real than the dominant one which obscures it in crosses. The presence and absence theory asserts that the recessive character has no objective existence except as the absence of the dominant one. Punnett, however, like most other Mendelians, retains Mendel's original terminology, even though it has lost its original significance. The small letter used to designate a recessive character means, on the presence and absence theory, only that there is nothing there, and it would seem might as well be dropped in the interest of simplicity. But if it can yet be shown that there are cases in which the recessive character is a reality, as Mendel thought, and not a mere negation, the old terminology may reacquire significance and utility.

A chapter devoted to the "interaction of factors" shows how the presence of one unit-character may affect the manifestation of an-

other independent of it in heredity, and how in other cases the joint action of two or more independent factors may be necessary to produce a single visible result. The cognate subject of reversion next comes in for discussion, and is finely illustrated by examples from the breeding of rabbits, sweet-peas and pigeons. Dominance is the subject of the next chapter, and is shown to be imperfect in heterozygous forms like the Andalusian fowl, or, in other cases, of reversed character in the two sexes, as in horns in sheep.

The origin of domesticated varieties from wild forms is next discussed. It is believed to occur by unit-character variation (mutation) but in several different ways as (1) by loss of factors, a method clearly illustrated in the case of sweet-peas both with historical data and data derived from breeding experiments; (2) by the reduplication of factors; (3) by the interpolation of new factors, in some cases unrelated in character, in others inhibiting in action. "Repulsion and coupling of factors" are hypothecated to explain peculiar ratios or the sex-limitation of characters in heredity. In discussing this subject Punnett follows Bateson closely, assuming that each sex possesses a factor not found in the other, and which repels certain sex-limited characters in gametogenesis.

The production of "intermediates" observed in many experimental studies of inheritance is explained with the help of (hypothetical) supplementary and inhibiting factors.

A finely written chapter on "variation and evolution" contrasts with the older views of the Darwinian period the newer views derived from the study of genetics, and shows how the theory of natural selection has been relieved of the burden of explaining the *origin* of new characters, and required only to explain their perpetuation. Protective mimicry is explained as due to parallel mutation rather than to actual imitation.

Another chapter discusses the economic aspects of genetics in the breeding of animals and plants, and the last one is devoted to "man." This delightful chapter is a literary gem, in which the author's power of keen analysis, of vivid imagination, and of clear exposition show to best advantage, not without a spark of genuine humor and a lot of good sense. He reviews the classic cases of Mendelian inheritance in man, of brachydactyly, night blindness, hemophilia, eye-color, etc. He considers the possible interrelations of physical and mental traits and the scientific basis of eugenics in the following passage:

> A discussion of eye-color suggests reflections of another kind. It is difficult to believe that the markedly different states of pigmentation which occur in the same species are not associated with deep-seated chemical differences influencing the character and bent of the individual. May not these differences in pigmentation be coupled with and so become in some measure a guide to mental and temperamental characteristics? In the National Portrait Gallery in London the pictures of celebrated men and women are largely grouped according to the vocations in which they have succeeded. The observant will probably have noticed that there is a tendency for a given type of eye-color to predominate in some of the larger groups. It is rare to find anything but a blue among the soldiers and sailors, while among the actors, preachers and orators the dark eye is predominant, although for the population as a whole it is far scarcer than the light. The facts are suggestive, and it is not impossible that future research may reveal an intimate connection between peculiarities of pigmentation and peculiarities of mind.
>
> The inheritance of mental characters is often elusive, for it is frequently difficult to appraise the effects of early environment in determining a man's bent. That ability can be transmitted there is no doubt, for this is borne out by general experience, as well as by the numerous cases of able families brought together by Galton and others. But when we come to inquire more precisely what it is that is transmitted we are baffled. A distinguished son follows in the footsteps of a distinguished father. Is this due to the inheritance of a particular mental aptitude, or is it an instance of general mental ability displayed in a field rendered attractive by early association. We have at present very little definite evidence for supposing that what appear to be special forms of ability may be due to specific factors. Hurst, indeed, has brought forward some facts which suggest that musical sense sometimes behaves as a recessive character, and it is likely that the study

of some clean-cut faculty such as the mathematical one would yield interesting results.

The analysis of mental characters will no doubt be very difficult, and possibly the best line of attack is to search for cases where they are associated with some physical feature such as pigmentation. If an association of this kind be found, and the pigmentation factors be determined, it is evident that we should thereby obtain an insight into the nature of the units upon which mental conditions depend. Nor must it be forgotten that mental qualities, such as quickness, generosity, instability, etc.—qualities which we are accustomed to regard as convenient units in classifying the different minds with which we are daily brought in contact—are not necessarily qualities that correspond to heritable units. Effective mental ability is largely a matter of temperament, and this in turn is quite possibly dependent upon the various secretions produced by the different tissues of the body. Similar nervous systems associated with different livers might conceivably result in individuals upon whose mental ability the world would pass a very different judgment. Indeed, it is not at all impossible that a particular form of mental ability may depend for its manifestation, not so much upon an essential difference in the structure of the nervous system, as upon the production by another tissue of some specific poison which causes the nervous system to react in a definite way. We have mentioned these possibilities merely to indicate how complex the problem may turn out to be. Though there is no doubt that mental ability is inherited, what it is that is transmitted, whether factors involving the quality and structure of the nervous system itself, or factors involving the production of specific poisons by other tissues, or both together, is at present uncertain.

Little as is known to-day of heredity in man, that little is of extraordinary significance. The qualities of men and women, physical and mental, depend primarily upon the inherent properties of the gametes which went to their making. Within limits these qualities are elastic, and can be modified to a greater or lesser extent by influences brought to bear upon the growing zygote, provided always that the necessary basis is present upon which these influences can work. If the mathematical faculty has been carried in by the gamete, the education of the zygote will enable him to make the most of it. But if the basis is not there, no amount of education can transform that zygote into a mathematician. This is a matter of common experience. Neither is there any reason for supposing that the superior education of a mathematical zygote will thereby increase the mathematical propensities of the gametes which live within him. For the gamete recks little of quaternions. It is true that there is progress of a kind in the world, and that this progress is largely due to improvements in education and hygiene. The people of to-day are better fitted to cope with their material surroundings than were the people of even a few thousand years ago. And as time goes on they are able more and more to control the workings of the world around them. But there is no reason for supposing that this is because the effects of education are inherited. Man stores knowledge as a bee stores honey or a squirrel stores nuts. With man, however, the hoard is of a more lasting nature. Each generation in using it sifts, adds, and rejects, and passes it on to the next a little better and a little fuller. When we speak of progress we generally mean that the hoard has been improved, and is of more service to man in his attempts to control the surroundings. Sometimes this hoarded knowledge is spoken of as the inheritance which a generation receives from those who have gone before. This is misleading. The handing on of such knowledge has nothing more to do with heredity in the biological sense than has the handing on from parent to offspring of a picture, or a title, or a pair of boots. All these things are but the transfer from zygote to zygote of something extrinsic to the species. Heredity, on the other hand, deals with the transmission of something intrinsic from gamete to zygote and from zygote to gamete. It is the participation of the gamete in the process that is our criterion of what is and what is not heredity.

Better hygiene and better education, then, are good for the zygote, because they help him to make the fullest use of his inherent qualities. But the qualities themselves remain unchanged in so far as the gamete is concerned, since the gamete pays no heed to the intellectual development of the zygote in whom he happens to dwell. Nevertheless, upon the gamete depend those inherent faculties which enable the zygote to profit by his opportunities, and, unless the zygote has received them from the gamete, the advantages of education are of little worth. If we are bent upon producing a permanent betterment that shall be independent of external circumstances, if we wish the national stock to become inherently more vigorous in mind and body, more free from congenital physical defect and feeble mentality, better able

to assimilate and act upon the stores of knowledge which have been accumulated through the centuries, then it is the gamete that we must consult. The saving grace is with the gamete, and with the gamete alone.

W. E. Castle

Harvard University

Plant Physiology, with Special Reference to Plant Production. By Benjamin M. Duggar. 13 × 20 cm. Pp. xv + 516, frontispiece and 144 figures. The Rural Textbook Series. New York, The Macmillan Co. May, 1911. Price $1.60.

The growing realization that a rational agriculture must rest upon the principles of plant physiology finds definite expression in the appearance of Professor B. M. Duggar's new text-book. As the title implies, this book is intended for agricultural students and those primarily interested in "plant production," and it should occupy a very necessary and permanently useful place in American agricultural colleges and experiment stations.

The choice of subject matter is governed by the centering of the entire treatment about the idea of the usefulness of plants in human affairs, so that relatively great importance is accorded those aspects of physiology which enter into present agricultural, horticultural and silvicultural theory and practise. Plant physiologists may be surprised to find that other portions of our present physiological knowledge are often but briefly and summarily treated. Thus, the whole subject of movements due to growth receives only about ten pages, while over twenty-six pages are devoted to variation and heredity, subjects as yet hardly to be considered as more than purely descriptive physiology. Many topics not usually treated under physiology find place here, and many illustrative examples are drawn from agricultural experience, so that the book should serve not only as an introduction to things physiological for those who care mainly for the practical manipulation of plants, but also as a key to many important agricultural points for those to whom etiological physiology is of primary interest. The book should therefore find a considerable use, also, in university laboratories. Enough excellently chosen titles are cited from the literature so that the more thorough-going student may find the book an adequate point of departure in the acquisition of a first-hand knowledge of the deeper aspects of the subject.

The literary style of this treatise is frequently abrupt and fragmentary, sometimes ambiguous. Technical terms are now and again introduced without previous explanation, the reader being left to surmise their meaning from the context; also the paragraph often lacks unity. A few examples of ambiguity may be noted. On page 58, regarding *Tillandsia,* we read that it "is provided with much the same type of water-absorbing hairs which give the entire surface a glistening appearance." Hairs have not been mentioned previously in this section, so that the reference of the word *same* is not evident. A comma should precede *which.* Again, on page 65 we find, "this diffusion is wholly independent of any convection currents due to changes in temperature, and it is true for all such soluble substances as sugar, common salt and the like." Here the personal pronoun is without antecedent. On page 195, in the sentence, "As organic matter so called, this element is linked chiefly with hydrogen," etc., "this element" has been mentioned only in the chapter title, "The intake of carbon," etc.

Some surprising inaccuracies occur, several of which may be mentioned here. At the bottom of page 207 "bioses" is obviously intended to denote *disaccharide hexoses.* The word "hydroscopic," page 245, should be *hygroscopic.* In the last paragraph of page 264 the word "hemlock" is used to refer to *Abies alba,* which it is not. On page 294, *à propos* of certain "roots or root branches which seem to be important in aeration," it is stated that "to these organs the term hydathodes has been applied": this word is applied to certain peculiar foliar openings or water pores, through which guttated liquid escapes. On page 402 barley is mentioned as "almost unknown southward," yet it is one of the main hay crops of the southern portions of Arizona

and California and the latter region is prominent in the production of barley grain for malting. The Imperial Valley produces large quantities of excellent barley.

The ancient and still commonly prevalent, though clearly illogical, confusion of osmotic with hydrostatic pressure finds, on page 69 of this text, its most recent expression. We are told that so long as water may be absorbed there is exhibited in plant cells "an hydrostatic pressure known as turgor. . . . Turgor is then the expression of the osmotic pressure of the cell." The Van't Hoff theory of osmotic pressure (gas-pressure theory) has been briefly stated in the preceding paragraph, so that the reader will picture turgor as brought about by the tendency of the solutes of the cell to expand within the limits of the solvent, the former substances being imprisoned within the plasmatic membrane, through which they do not pass. But the reader is now told that the internal pressure which produces turgor is *hydrostatic,* which can only mean that it is due to *water.* He remembers that the plasmatic membrane is permeable to water and becomes hopelessly muddled.[1]

Serious misconception may arise from the following, which occurs on page 440: "The method of reducing toxicity by solid particles [in water-culture solutions] is usually denoted [*sic*] adsorption." Of course the general phenomenon of adsorption is well-known physically and receives a large amount of attention in the recent hand-books of colloid chemistry, so that the implication that this phenomenon is known only, or even mainly, in connection with physiological solutions, is much to be regretted. Following the above sentence comes a brief statement of the usual explanation of adsorption, and then we enter again upon troubled ground, in the statement that "another explanation is that the solid substances offer obstacles to the free movement of the solvent particles." Obviously, "solvent" should be replaced by *solute,* but, even with this modification, the sentence can not stand, for it is well established that the effect of solid particles (such as lamp-black and quartz flour) upon a toxic solution remains manifest after their complete removal from the solution.[2]

In general, Professor Duggar's treatment of the subject is exceptionally *safe;* we find no dogmatic statements in the entire book, and the careful wording will hardly fail to impress upon the student the importance and desirability of that inestimable attribute of the trained thinker, the habit of suspended judgment. The fact that the author employs the word *suggest* where many others would have written *show* or *demonstrate,* indicates clearly the wholesome tendency of the treatment. Indeed, some critics will probably find fault with many paragraphs because of the indefinite conclusions reached; the method of caution is carried farther than it need be at certain points. The reviewer believes, however, that we touch here upon one of the most commendable characteristics of Professor Duggar's work.

Another admirable quality which deserves special mention here is the almost complete avoidance of teleological or anthropomorphic implications. We find no "adaptations" here discussed, and seldom is a process said to occur "for" future "needs." While not absolutely free from teleological lapses—here and there occur such statements as this, that "the seed and tuber are effective propagative devices"—yet the work of Professor Duggar has clearly shown, once for all, that it is quite possible and practicable to discuss plant phenomena without indulging in those anthropomorphic colorings which characterize a still very prevalent type of biological writing. At the same time, our author does not make his book unreadable to the beginner by seeking to put all statements in terms of pure energetics. The secret of his success in this direction lies perhaps mainly in the fact that he develops human interest by emphasizing the usefulness of plants to man, rather than by virtually

[1] For a discussion of a similar statement, made years ago, see Livingston, B. E., "The Rôle of Diffusion and Osmotic Pressure in Plants, p. 31, Chicago, 1903.

[2] For example, see Bulletins 28 (1905) and 36 (1907), Bureau of Soils, U. S. Dept. Agric.

humanizing or personifying the plant through attributing to it various human concepts, such as fear, reason and the like.

Burton E. Livingston
The Desert Laboratory

NOTES ON METEOROLOGY AND CLIMATOLOGY

Rapid progress is being made in the United States in the opportunities for instruction offered to students in meteorology and climatology. Moreover, college students, especially those in medicine, engineering, agriculture and forestry, are showing an increasing interest in these sciences. At the University of Minnesota, where instruction in meteorology was first given only four years ago, the classes under Professor E. M. Lehnerts last year numbered eighty-seven students, being the largest in this branch of science in the country. At the University of Wisconsin there is now a separate department of meteorology in which three courses open to undergraduates and four courses open to graduates and undergraduates are given by Mr. Eric R. Miller, of the U. S. Weather Bureau. As a result of the policy of the university to cooperate with the scientific branches of the national government, the local office of the Weather Bureau is located in one of its buildings, North Hall, and the official in charge lectures in the university. A similar situation is found at Johns Hopkins University. At the University of Nevada instruction in meteorology will be offered for the first time during the coming college year. It will be given by Mr. S. P. Fergusson, formerly of Blue Hill Observatory, who during the past year has had charge of the meteorological work at the Experiment Station in Reno. Mr. W. G. Reed, Jr., for several years past an assistant under Professor Ward in Harvard University, goes to the University of California at the beginning of the new year to teach meteorology and climatology.

A new edition of the "International Cloud Atlas" has just been prepared by MM. A. Hildebrandsson and L. Teisserenc de Bort, to whom the publication of the work has been entrusted by the International Meteorological Committee. The first edition of the atlas, which appeared in 1895, was soon out of print, but it accomplished its purpose—international uniformity in cloud nomenclature and the recording and publication of cloud data by means of symbols. At the International Meteorological Conference at Innsbruck in 1905 certain improvements were suggested, and these have been incorporated in the new edition. The latter consists of complete definitions of the various kinds of clouds and instructions to observers, all printed in three languages, together with twenty-nine photographs of the various types of clouds, which, with their backgrounds, are shaded and colored as in nature. Only clouds of typical form are shown, making it an easy matter for one to recognize the various kinds of clouds and to learn the names by which they are known. The more important changes made in the second edition as a result of the resolutions of the Innsbruck Conference are the following: (1) Stratus cloud is defined as "a uniform layer of cloud resembling a fog but not resting on the ground," instead of "a horizontal sheet of lifted fog." The complete absence of details of structure differentiates stratus from other compact cloud forms. (2) A new term, lenticularis, is used for certain cloud forms, particularly frequent on days of sirocco, mistral or foehn, which have an oval shape and occasionally show irisation. Clouds of this kind are cumulus lenticularis and stratus lenticularis. (3) Observers are urged to designate, by means of a special symbol, a cloud which is specially characteristic of its type, or a cloud from which rain falls. (4) Distinction is also made between a fog which wets exposed surfaces and one in which exposed surfaces remain dry.

Representatives of the weather services of two foreign countries visited the United States recently to study the methods used here. One was Professor Torahiko Terada, of Tokio, Japan, who is at present on a tour

around the world investigating the aerological work of the leading nations. The weather service of Japan is about to inaugurate research of this kind, and for this reason Professor Terada was delegated with the task of studying the methods and inspecting the apparatus now in use in other countries. The second representative was Mr. Edward C. Barton, of Brisbane, Australia, who visited the United States and Canada for the purpose of studying meteorological work with the hope that the information thus gained might be used to improve the Australian weather service. Methods of collecting and disseminating data, forecasting, the publication of weather maps and the instruction offered both under the government and independently among the colleges were especially investigated by Mr. Barton. Pilot and sounding balloons are now used in upper air research in Australia, but kite flying for meteorological purposes has not been begun as yet.

A PAPER entitled "The Vertical Temperature Distribution in the Atmosphere Over England, and Some Remarks on the General and Local Circulation" was read before the Royal Society of London by Mr. W. H. Dines on May 11, 1911, and is published in the transactions of that society. It is based upon the results obtained from about two hundred sounding balloon ascensions in England during the last four years. He says, "Any one working up these figures can not fail to notice that the temperature of the upper air over England is largely dependent upon the height of the barometer, and that above ten kilometers the temperature is far more dependent upon the barometer than it is upon the season." Tables which he gives show that the lower strata are cold in a cyclone and warm in an anticyclone, a condition which is reversed above. At ten kilometers the intermediate type of weather has the lowest temperature, the temperature gradient ceasing at eight kilometers in the cyclone, but not until twelve kilometers in the anticyclone. Temperature conditions indicate an ascending current in a cyclone starting close to the ground and reaching up to the isothermal region, the stratosphere, and extending over a larger and larger area as it rises, the whole forming roughly the frustrum of a cone with its apex downwards. In an anticyclone it starts from a height of about eleven kilometers, spreading out as it descends, it too forming a cone, but with its apex upwards. The height of the isothermal region varies directly with the barometric pressure at the ground, while the temperature of the air at the commencement of the isothermal varies inversely as the latter. He also finds that the annual range in temperature decreases from the surface up to two or three kilometers; it then continues nearly constant up to about eleven kilometers, at which point it is abruptly reduced to less than half its former value. In the strata above one or two kilometers the maximum and minimum values are delayed for about a month, but above the point at which the vertical gradient ceases they occur at the summer and winter solstices. If the theory of local circulation given be correct it follows that the winds must continue upwards to the height at which the isobaric surfaces are level planes, or rather spheroids concentric with the earth, a height estimated at twenty kilometers.

ONE of the most valuable fields of activity of the U. S. Weather Bureau is that related to frost, concerning which several interesting articles appear in recent numbers of the *Monthly Weather Review*. In the January number Mr. W. M. Walton, Jr., tells how, after burning 3,300 gallons of fuel oil in heaters placed in a fruit orchard in Indiana during the cold April of 1910, the blossoms were protected until the twenty-second, when a high northwest wind accompanied by a temperature of 25° destroyed all prospects of tree and bush fruit crops. However, two acres of strawberries gave an abnormally large crop after they had been protected by means of 180 oil heaters during three nights of frost with temperatures down to 25° and lower. In two papers in the February number, Professor Alexander G. McAdie, of San Fran-

cisco, tells of efforts to protect California fruits from frosts. It is a matter of credit to the Weather Bureau and its California forecasters that during the winter of 1909–10 in that state there was not a single forecast of injurious frost that was not fully verified, and, what is more satisfactory, there was not a single frost injurious to fruit occurring during that period which was not forecast from twelve to thirty-six hours in advance. Efforts are being made to select hardy plants which will resist low temperatures, to render the plant dormant and not sensitive during the cold periods, and also to fight the cold and minimize exposure thereto by producing heat artificially. In the April number Mr. E. M. Gruss, of Houston Heights, Texas, tells of the beneficial effects of smudge fires to protect the fruit and garden crops in the southern part of that state by means of checking the nocturnal radiation. He points out the necessity of rapid action the moment frost is predicted, and also recommends the use of temporary coverings of hay, straw, soil, slatted roofs or mats, or by means of flooding or spraying. At Grand Junction, Col., in the vicinity of which temperatures as low as 15° were observed on the night of April 12 last, ample forecasts were widely disseminated by telephone, and orchard temperatures were kept above the danger point by means of artificial heating. In the same number of the *Review* Dr. P. F. Homer, of Pleasant Grove, Utah, tells of work being done there to determine the resistance of fruit buds to frost and the factors which bring about the remarkable differences noted whereby a freeze will kill one bud on a twig and leave unharmed another one adjacent to it, or will destroy the blossoms on one tree and not affect another of the same species near by. Mr. W. E. Bonnett, local forecaster at Fresno, Cal., also tells of successful efforts in fighting frost in the California vineyards. On April 13, when the most damaging frost in many years occurred near Fresno, and reliable instruments recorded temperatures of 27°, vineyards were protected by means of fire pots in which was burned a specially prepared fuel of sawdust and shavings. He points out the fact that danger from frosts lies within very narrow limits, and states that growers in his vicinity are awakening to the fact that complete protection is easy and sure. In another note Professor McAdie describes a new device called an "antifrost candle," a cartridge which consists of a cylindrical tube containing slow-burning material. These cartridges are suspended in an orchard just beneath the fruit, the ends are lighted, and the heat produced is distributed at the particular level where it is most needed.

Andrew H. Palmer
Blue Hill Observatory,
August 1, 1911

SPECIAL ARTICLES

THE NITROGEN AND HUMUS PROBLEM IN DRY-FARMING

The Utah Experiment Station has been conducting investigations for several years regarding the effect of crop production, under strictly dry-farming methods, upon the nitrogen and humus content of the soil. A preliminary report[1] of this work was issued last year. The writer found, contrary to the teachings of modern agriculture, that crop production had not caused a decrease in the nitrogen and humus content of the cultivated soil when compared with that of the adjacent virgin soil.

Recently a criticism of this report appeared in Science[2] written by Mr. C. S. Scofield, of the United States Department of Agriculture. There are two main points in Mr. Scofield's criticism: first, the characteristic cultural methods in vogue in the Cache Valley, Utah, were not emphasized so as to bring out the differences between these and the methods in vogue in the Great Plains area of the United States; second, the noted increase in nitrogen and humus content was not correlated with the yields on the cropped land.

[1] Utah Experiment Station, Bulletin No. 109.

[2] Science, Vol. XXXIII., No. 855, May 19, 1911, p. 780.

The writer did not bring out the characteristic differences in the cultural methods in vogue in the Cache Valley, Utah, as compared with the cultural methods in vogue in the Great Plains area. Neither did he bring out the differences in cultural methods in vogue in the Cache Valley, Utah, and in Russia. And why should he? He was writing of neither the soils and cultural methods of the Great Plains area of the United States nor of Russia. He was writing a preliminary report of a purely local phase of the general problem and in this connection he said: "The data presented herein are very interesting and instructive, but one must not generalize too much from the limited amount of information furnished. In studying the results, the nature of the soil and cultural methods of Cache Valley should be kept in mind. . . . *Such soils are probably not found in any other extensive dry-farming district outside of Utah.*"[3] In the face of this statement, it seems difficult to see how any one could accuse the writer of attempting to apply these results to the Great Plains area.

The noted increase of nitrogen and humus was not correlated with the yields of wheat because the accurate yields of wheat were not available. The writer felt that the reputed yields of wheat, obtained from the average farmer, whose only record was his memory and who even had no accurate knowledge of the acreage harvested each year, could have but little if any scientific value. The writer felt that a general statement that "Some of the farms of this district have been under cultivation for forty-five years and apparently yield as good crops as they ever did" was fully as valuable. He still feels that this statement is as valuable as Scofield's[4] regarding the yield of wheat in this same section, wherein he says, "While actual comparison is of course impossible, there are reasons for believing that some of these fields are capable of producing better crops now than when first plowed."

[3] Utah Experiment Station, Bul. 109, p. 15.

[4] U. S. Dept. Agr., Bureau of Plant Industry, Bulletin 103, p. 31.

Since the report was only a preliminary one and the investigation was being continued in the Juab Valley on the Nephi Experimental Farm where the accurate record of yields of wheat was available since the establishment of the farm on virgin sagebrush soil, the writer felt that the noted increase of nitrogen and humus could not but be of interest to agronomists and agricultural chemists in itself, leaving to a future publication the correlation of such an increase with the accurate recorded yields of wheat or other crops.

The investigations on the Nephi Farm have been completed and the results are given herewith. The virgin soil was obtained at the time of the location of the farm in 1903. The samples of virgin soil are composites of twenty-five separate borings on a forty acre tract, so they fairly represent the composition of the soil of the farm in its virgin state.

The samples from plots 82, 83 and 144 were obtained in 1910, seven years after commencement of cultivation. Each sample is a composite of two separate borings.

TABLE I. NITROGEN, HUMUS AND ORGANIC CARBON IN CULTIVATED AND VIRGIN SOIL

Results reported as per cent. of dry soil

Treatment	Depth in Inches	Nitrogen	Humus[5]	Organic Carbon[6]
Virgin soil of farm.....	0–12	0.116	1.34	0.315
	12–24	0.103	0.89	0.436
Continuous cropped, plot 82.....	0–12	0.117	1.39	0.558
	12–24	0.092	0.91	0.477
Alternate cropped and fallow, plot 83.....	0–12	0.108	1.01	0.611
	12–24	0.065	0.78	0.440
Alfalfa, plot 144...	0–12	0.110	1.33	0.599
	12–24	0.095	1.38	0.392

The nitrogen and organic carbon have not decreased in the cropped soil when compared with the composition of the same soil in its virgin state. The difference in results for nitrogen in the cropped and virgin soil is

[5] By method of Mooers and Hampton, *Jr. Am. Chem. Soc.*, 1908, Vol. 30, p. 805.

[6] By method of Pettit and Schaub, *Jr. Am. Chem. Soc.*, 1904, Vol. 26, p. 1640.

within the experimental error of sampling and analysis. The total organic carbon has markedly increased in the cropped soil. The "humus" has remained practically the same except on the alternate cropped and fallow plot where a decrease has occurred.

The yearly yields of the plots since the beginning of crop production on this farm are recorded in Table II.

TABLE II. YIELD OF WHEAT ON PLOTS CROPPED CONTINUOUSLY AND ALTERNATELY CROPPED AND SUMMER-FALLOWED

Yield of wheat reported as bushels per acre

Plot No.	1904	1905	1906	1907	1908	1909	1910
82	17.75	8.9	17.9	16.5	13.4	14.58	7.8
83	15.16	fallow	35.6	fallow	32.7	fallow	9.9

The alfalfa plot was utilized for experiments in alfalfa seed production. No yield of seed was obtained. The seed experiment was discontinued in 1908. In 1909 a yield of 2,775 pounds of hay was obtained. The crop failed to mature in 1910.

With respect to the characteristic cultural methods in vogue in Utah, it may be noted that one of the reasons why the grain is harvested with the header is that the straw is so short that it is difficult to use a binder. Wherever a binder is used, the straw is of a ranker growth which permits its use. Now, this being true, it is very doubtful if there be more straw in the stubble on dry-farming land in Utah where the header is used than in the stubble on land where the ranker growth of straw permits the use of the binder. The writer confesses that he knows of no accurate data upon this point.

The explanation of the noted increase of humus and nitrogen in the dry-farming soils of Utah must be sought elsewhere. The effect of the cultural methods, while not of paramount importance, is a possibility which ought not to be ignored. In many sections of the country, such as the Mississippi valley, there is a sharp line of demarkation between the surface soil and subsoil, due to the accumulation of humus in the surface soil formed from the decayed roots of the native grasses and the addition of their residues. The marked change in color of the subsoil indicates that the roots of the native grasses have not penetrated to greater depth. In the soils of Utah, no such line of demarkation occurs between surface and subsoil, which clearly indicates that the roots of the native vegetation have penetrated to great depths. The significance of the deep-rooted character of native plants in arid soil was first noted by Hilgard.[1] The characteristic native vegetation of the dry-farming soils of Utah is sagebrush, the roots of which penetrate to great depths and, being of a woody nature, do not undergo decay rapidly. The foliage is very scant and adds little to the humus-forming material of the soil. The native grasses occasionally occurring with sagebrush are also deep rooted. In a word, there is limited possibility for the formation of humus in the virgin surface soil as compared with other sections of the country where the root system does not penetrate so deep and the native vegetation of a humus-forming type is more abundant. Therefore, in the dry-farming soils of Utah, the addition of *any* straw must increase the organic matter of the plowed surface of the soil as compared with the virgin surface soil which receives little or no organic matter of a humus-forming type. The other factors as noted in Bulletin No. 109 should also be considered in connection with the increase of nitrogen and humus in the cultivated soil.

Robert Stewart

Chemical Laboratory,
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[1] "Soils," p. 174.

THE AMERICAN CHEMICAL SOCIETY. III

Division of Industrial Chemists and Chemical Engineers

G. D. Rosengarten, *chairman*
F. E. Gallagher, *secretary*

The Rapid Analysis of Alloys: Guillermo Patterson, Jr.

The Testing of Inks, Typewriter Ribbons and Carbon Papers: Percy H. Walker.

Hop Standards: Considered from the Chemical Standpoint: H. V. TARTAR.

Losses in the Storage of Coal: HORACE C. PORTER and F. K. OVITZ.

The paper describes tests made by the U. S. Bureau of Mines at various points during the last three years to determine the loss in heating value and the physical deterioration of several kinds of coal while in storage. Tests at various U. S. Navy Yards (Portsmouth, N. H., Norfolk, Va., and Key West, Fla.) and at the Pittsburgh station of the Bureau, on New River (W. Va.) coal, have been carried on for eighteen months both in the open air and under water, so as to show the amount of the saving accomplished by the latter method. Pocahontas coal has been stored in the open air on the Isthmus of Panama for nine months, and is being tested to show the deterioration of this grade in a hot climate. Pittsburgh gas coal has been stored in open bins exposed to the weather at Ann Arbor, Mich., and also submerged under water, so as to determine both the loss of heat value and the deterioration in gas-making qualities (the latter phase of the investigation being under the auspices of the University of Michigan and the Michigan Gas Association). Sheridan (Wyo.) sub-bituminous coal (black lignite) was stored in outdoor bins at Sheridan, Wyo., for nearly three years, and the amount of deterioration and slacking under different conditions determined.

The results show briefly that deterioration in the open varies considerably with the kind of coal, the Appalachian coals being only slightly affected while the younger coals of the west, which differ from the Appalachian in their chemical character, are more easily oxidized and weathered.

New River coal loses less than 1 per cent. in heating value during open-air exposure for one year, and no loss at all occurs during storage under water. The wetting of the coal by submergence reduces its evaporative power more than enough to offset any saving accomplished through the prevention of deterioration. The only advantage of submergence in case of this coal, therefore, is the avoidance of all risk of spontaneous combustion. Fine coal deteriorates more in all cases than run-of-mine.

Pocahontas coal, during nine months' open-air storage at Panama, lost only 0.3 per cent. in heat value. Sheridan, Wyo., sub-bituminous lost 3–5 per cent. in heat value during three years' storage in outdoor bins and slacking penetrated only about one foot from the surface. Pittsburgh gas coal stored in outdoor open bins lost nothing in heat value during the first six months.

Need of Professional Code of Ethics among Chemists: LUCIUS P. BROWN.

Storage Battery Efficiency: J. S. STAUDT.

A New Modification of Gas Analysis Apparatus: B. G. KLUGH.

Refractories and Laboratory Appliances made of Alundum: P. A. BOECK.

The rapid advance in high temperature work and furnace construction during the past few years has necessitated the development of a high-grade refractory material to withstand excessive temperatures. Electrically fused alumina has long been known to have exceptional refractory properties, but on account of the difficulties in the manufacture of articles of this material its use has been limited. Fused alumina under the trade name of "alundum" has been made for abrasive purposes for the past ten years by the Norton Company, Worcester, Mass., who have lately adapted this material for refractory purposes.

There are two varieties of fused alumina or "alundum" made.

One is a dark, brown, dense vitreous body having a density of 3.9 and a hardness between corundum and diamond. This is made by calcining bauxite and fusing it in a water-cooled electric furnace, where the impurities in the form of iron oxide, silica and titanium oxide are reduced to a considerable extent, leaving the material in the furnace 92 to 95 per cent. alumina. The other is a material of higher purity, containing more than 99 per cent. alumina, made by carrying the purification process further. This is the material most generally used for refractory work.

The alundum comes from the furnaces in pigs weighing about five tons each, which are broken up, crushed and graded to grain of a uniform mesh. In making refractories of this material grain of a suitable size or combination of sizes is mixed with a refractory bond of a ceramic nature and the pieces molded, pressed or cast into shape and fired at high temperatures. The kind and amount of bonding material, and the size or combination of sizes of grain used, are varied to give properties to suit the conditions under which the articles are to be used. In this way their properties may be modified or controlled to adapt them to any refractory use. Attempts have been made to make articles of cast alundum, which have been only partially successful.

The physical properties of bonded alundum refractories are as follows:

High Melting Point.—Between 1,950 and 2,100 degrees Centigrade.

High Thermal Conductivity.—2.1 times that of vitrified firebrick and 1.6 times that of porcelain.

Low Electrical Conductivity.—Even at elevated temperatures it is a better insulator than porcelain.

Low Thermal Expansion.—This is linear and varies between .0000085 and .0000059.

High Mechanical Strength.—This can be varied and is dependent to a certain extent on the other properties desired.

Porosity.—This can be varied between wide limits from impervious bodies to those having a high porosity which can be used for the filtration of liquids of any gravity.

Filtering crucibles of the gooch type can be used for filtering precipitates quantitatively without any previous preparation and can be used repeatedly.

Extraction thimbles are made for all kinds of extraction work and can be cleaned by igniting over a gas burner.

This material is especially useful in small wire wound resistance furnaces, as it prevents overheating and corrosion of the resister and has high thermal conductivity.

Crucibles for analytical work of a general nature such as drying and burning filter papers, coal analysis, etc., have been found more rapid and longer lived than porcelain. Crucibles for melting platinum and high melting alloys, where no slags are present, have been found very efficient.

Combustion boats of alundum are useful in the determination of carbon in steels, as the iron oxide formed does not combine with the alumina at the temperature of combustion. For very high temperatures it has been found advisable to use a lining of specially prepared carbon-free alundum between the boat and the sample. When used in this way the boats last indefinitely, as many as 500 combustions having been made in the same boat.

The Determination of Vanadium in Vanadium and Chrome-vanadium Steels: J. R. Cain. (*Bull. Bur. Standards*, 7, No. 3, p. 377; *J. Ind. and Eng. Chem.*, 3, July, 1911.)

Various errors in the usual methods for determining vanadium in steel are pointed out and in a few cases methods for correcting or eliminating these are indicated. A new method based on precipitation of the vanadium by cadmium carbonate followed by electrolysis, reduction and titration, is described.

Determination of Dust in Blast Furnace Gas: L. A. Touzalin.

Dust determinations can be made in any blast-furnace gas at any stage of its passage from the furnace to stoves, boilers or cleaners, if proper means are used to insure the correct rate of withdrawing the sample from the gas main. When samples are withdrawn through a sampling pipe at a velocity less than that in the main, high results will be obtained. Conversely, when the sampling velocity is too great low results are obtained. By means of the proper apparatus, described in the paper, very satisfactory efficiency tests may be run on a system of gas cleaners. This leads to the development of changes in construction which often have a remarkable effect on such efficiency. The apparatus described and the method of operating the same are in constant use at the South Works of the Illinois Steel Company.

The Examination of Fir Oil obtained by Steam Distillation of Douglas Fir: Henry K. Benson and Marc Darrin.

The Wood Distillation Industry of the Pacific Northwest: Henry K. Benson.

Ratfish Oil as a Paint Material: Henry K. Benson and Wallace Eshleman.

Note on the Analysis of Nitrous Oxide: Warren R. Smith and Edwin D. Leman.

On attempting to analyze nitrous oxide as supplied in cylinders in the liquid state, we found ourselves confronted with certain difficulties. Consecutive samples of the gas as drawn off from the cylinders will vary somewhat in composition, apparently for the reason that the impurities (oxygen and nitrogen) are in solution in the liquid nitrous oxide, and sample of gas as drawn may or may not have reached a state of equilibrium with the liquid. This evidently will depend on the rate at which the sample is drawn, the length of time elapsing between drawing samples, and various other factors. Duplicate results can easily be obtained from a sample large enough for several analyses, but there is no certainty as to what such a sample represents. Again there is a regular progressive change in the composition of the samples as drawn from the cylinders. The impurities escape at a more rapid rate proportionally than the nitrous oxide in which they are dissolved, and the nitrogen escapes faster than the oxygen. Below are three sets of figures obtained from the same cylinder of material.

	True Content of Cylinder	Nearly Full	Nearly Empty
Per cent. O_2	1.4	2.9	0.7
Per cent. N_2	5.2	11.2	1.6
Per cent. N_2O	93.4	85.9	97.7

We found that all these difficulties can be avoided by the simple expedient of inverting the cylinder and drawing a sample from the bottom of the liquid. That this method gives a fair sample we have proved by drawing a sample in this manner and comparing the result obtained from this sample with that obtained by taking samples at regular intervals during the escape of a whole cylinder of the gas, plotting the results obtained from these samples on rectangular diagram paper and calculating percentages from the areas so obtained.

	From Inverted Cylinder	From Diagram
Per cent. O_2	1.1	1.0
Per cent. N_2	3.1	3.3
Per cent. N_2O	95.8	95.7

Oxygen was determined by absorption with pyrogallate, nitrous oxide by explosion with hydrogen, and nitrogen by difference. No impurity other than oxygen and nitrogen was detected in the cylinders examined except in one specimen which contained a small amount of carbon dioxide.

The variation in composition in the gas as drawn from the cylinder must be of significance in the administration of the gas, and the method of getting a fair sample should be applicable to other liquefied gases such as carbon dioxide and ammonia.

A Differential Test for Chloride and Dioxide Substitutes: CHAS. P. FOX, Akron, Ohio.

The reclaimed rubber trade recognizes two grades or varieties of *"so-called"* substitutes. These substitutes have their origin in certain very soft rubbers which have been *firmed* or *hardened* by action of chemicals. They are known as "chloride" or "dioxide" substitutes. Often it is interesting and valuable to trace the method of manufacture of these grades. The following method suffices:

Fuse in a large *nickel* crucible a mixture consisting of *sodium* or *potassium hydrate* and *potassium nitrate* (1 to 5). Add the rubber, in fine pieces, slowly, using cover on crucible and continuing fusion until a white mass, on cooling, is obtained. Cool; dissolve in hot water, acidify with nitric acid, boil thoroughly to expel carbon dioxide and nitrous acid fumes and filter. Add to filtrate excess of *barium nitrate;* a white precipitate indicates sulphur. Remove the barium sulphate by careful filtration and add *silver nitrate;* a white precipitate shows presence of *chlorine.* The presence of both of these precipitates indicates a chloride substitute. The presence of sulphur alone gives the clue to a sulphur dioxide production.

By using *one* gram of the substance and 10 grams of the fusing mixture the test is easily carried out with definite results. A blank test should always be conducted with the reagents, especially those concerned in the fusion operation. In most cases the blank test will give an opalescence with the silver solution. However, if the amount stated has been used and chlorine be present the precipitate will be heavy enough to remove all doubts.

Marine Fiber: CHAS. P. FOX.

American Consul John F. Newell, at Melbourne, Australia, has recently called attention to the use of a seaweed fiber in the manufacture of textiles. This fiber has its origin in the leaves and stems of *Posidenia Australis.* Large quantities of this fiber are found in Spencer Gulf. According to the Jewell report, extensive deposits ranging from four to twelve feet in thickness are found, in shallow water, mixed with clay and sand and shells. The material is dredged, roughly dried on the beach, and then transported to the factory, where it is cleaned, sorted and baled.

The raw material is light brown, resembling unbleached flax fiber. Fiber mixed with numerous pieces of flat, satin-like leaves. The separate fibers vary in length from one to six inches. They are firm, smooth and only of slight strength. This fiber finds a use in the manufacture of certain classes of woolens. When mixed with wool it is said to weave and dye better than cotton and to be much cheaper.

Through the kindness of Mr. Holweeay, of Brown & Dureau, Melbourne, we have examined samples of the crude fiber and of cloth containing one third marine fiber, one third wool and one third cotton. In weaving, Lincoln or Crossbred wool gives better results than Merino.

This fabric weighs 8 oz. per square yard and gives a tensile, per 1 in. width, of 22 lbs. for both filler and warp.

A Method of Analysis of Lead Ores: JOHN WADDELL.

This paper gives details of a method of determining lead in ores, especially those rich in lime.

The method consists in precipitating the lead as chromate, which, when dissolved in hydrochloric acid, liberates iodine from potassium iodide and the iodine is titrated with sodium thiosulphate.

A Method of Analyzing some Commercial Gold Alloys: James O. Handy.

Gold alloys containing Au, Ag, Cu, Zn and Sn are reduced to filings for analysis.

0.5 gram is dissolved in aqua regia, 4 HCl: 1 HNO_3. The excess of acid is boiled off, the liquid is diluted and AgCl precipitated by boiling. Filter, wash, dry and weigh.

Filtrate plus 5 per cent. of concentrated HCl, is treated with H_2S. In the filtrate from the sulphides, the Zn is separated as carbonate and weighed as oxide.

The SnS is dissolved out of the sulphide precipitate by 30 per cent. HCl, and is again precipitated as SnS after nearly neutralizing with ammonia. Weigh as oxide.

The Cu is dissolved out of the Au + CuO mixture obtained by burning off the sulphides of gold and copper. Concentrated HNO_3 is used. H_2SO_4 is added and the HNO_3 boiled off. After cooling, water and sodium acetate are added. Boil, cool, add KI and titrate Cu by hyposulphite.

Au and Ag are determined by scorification with lead and borax—silica flux. A "control" assay to check losses of Au and Ag is run with a mixture of metals of approximately the formula of the alloy itself. The Au and Ag are determined together and then separated in the usual manner. Results by corrected fire-assay are more exact than by wet methods in most hands.

Alloys of gold containing up to 26 per cent. Ag, 18 per cent. Cu, 7.5 per cent. Zn and 2 per cent. Sn have been successfully analyzed by this method.

Concentration and Purification of Iron Ore, High in Sulphur, by Roasting in a Rotary Kiln: James O. Handy.

Division of Fertilizer Chemistry

Paul Rudnick, *chairman*
J. E. Breckenridge, *secretary*

Note on the Neutral Permanganate Method for the Availability of Organic Nitrogen: John Phillips Street.

Further tests with experimental mixtures, in which the permanganate availability of the nitrogenous material was known, showed that under certain conditions very misleading results were obtained, particularly with certain high-grade ammoniates like dried blood. Investigation showed that muriate of potash had no effect on the availability results, but that as the relative amount of acid phosphate was increased the availability of the nitrogenous material decreased, for instance, dried blood from 97 to 59 and tankage from 91 to 78. It was found that the addition of one gram of sodium carbonate prior to the introduction of the permanganate solution gave results close to theory with all the materials tested, except garbage tankage which gave somewhat high results, but not high enough to lead to erroneous interpretation of the analysis.

The Use of Fused Silica Dishes for Potash Determination in Fertilizers: W. D. Richardson.

The Availability of the Insoluble Nitrogen in Certain Commercial Fertilizers: B. L. Hartwell and F. R. Pember.

Results secured by growing crops in pots showed that the insoluble nitrogen of twelve potato fertilizers made by different manufacturers must have been derived from fairly high-grade material. The availability of this nitrogen was found to be about the same both by the crop results and by the alkaline permanganate method recently adopted by certain northeastern states for the laboratory determination of the character of the materials used as sources of the insoluble nitrogen of fertilizers.

The Use of Alundum Crucibles for Total Phosphoric Acid and Potash Determinations in Fertilizers: W. D. Richardson.

The Availability of Nitrogen in Complete Fertilizers: Jacob G. Lipman.

Notes on Estimation and Valuation of Potash: P. F. Trowbridge.

Reports from the following committees were received and will be published in the *Journal of Industrial and Engineering Chemistry:* Paul Rudnick, for the committee on nitrogen; G. A. Farnham, for the committee on phosphoric acid; J. E. Breckenridge, for the committee on potash; C. F. Hagedorn, for the committee on phosphate rock; F. B. Carpenter, for the committee on fertilizer legislation.

Division of Pharmaceutical Chemistry

B. L. Murray, *chairman*
F. R. Eldred, *secretary*

A Few Results Obtained from Pepsin Assay: O. P. Eyre.

Observations upon the Assay of Digestive Ferments: Howard T. Graber.

The three classes of organic foodstuffs considered and the rôle each plays in the nutrition of the body. Proteids are the principles from which all living cells are made, while the carbohydrates and fats serve as the natural fuel foodstuffs of the body.

Digestion considered as a chemical process and can be brought about by pure chemical means, but much more slowly than by the digestive enzymes or ferments.

Enzymatic activity considered. Characteristics peculiar to the enzymes: (1) distinctly specific in their activity, (2) their reactions are incomplete, (3) reactive to environment, (4) the *kind* of proteid, albumenoid or starch acted upon a big factor in the ultimate amount digested.

The enzyme pepsin considered; showing by experiment that the fresh egg of the epicure and housekeeper is not so easily digested as one from five days to one week old.

The enzyme pancreatin considered.

The two assays of the pharmacopœia discussed and a third assay recommended which measures the amount of steapsin or the fat splitting enzyme present.

Pancreatin is more active upon corn starch than upon potato starch.

The enzyme rennet and a method recommended for its standardization. As in the animal kingdom we have juices whose specific function is to tear asunder the food material to make it available for the needs of the body, so in the plant kingdom we find analogous enzymes whose function is exactly the same, that is, to render the plant foods assimilable. Most important of these from our standpoint are bromelin and papain. Bromelin is the enzyme existing in the fruit of the pineapple. Papain exists in the fruit of the pawpaw, a tree growing in the Bahamas and West Indies. Collection of papain described and an assay recommended by means of which the amount of raw beef digested by the papain in a definite period of time is determined.

Conclusions—(1) The composition of the white of the egg, chemically and probably even physically, when used for the assay of pepsin, has a great bearing upon the apparent strength of this ferment. The albumen seems to be more difficult to digest the first twenty-four hours after the egg is laid, and a change gradually takes place until after about five to seven days it has reached its maximum solvent condition. After this period its digestibility gradually diminishes.

(2) In the assay of pancreatin for starch hydrolysis, as well as all the diastasic ferments, the kind of starch used is of prime importance, and in stating the strength of each it should be in terms of the particular starch employed.

(3) The papain seems to be equally active on any kind of raw beef when acting in an acid media, but if the character of the beef is changed, as, for instance, by cooking, papain loses its solvent action upon the proteid.

(4) Rennet is influenced, in testing its coagulating power, by: the condition of the milk, its chemical composition such as the presence and quantities of inorganic salts, particularly those of calcium; the manner of mixing the rennet with the milk; the brand of cows from which the milk is taken, and, lastly, the temperature at which the milk was kept before using and during the test.

Pharmacopœial Revision: JOSEPH P. REMINGTON.

Investigation made with Dry Egg Albumin, in View of Replacing the Albumin Coagulated in the Egg, for Greater Accuracy in the U. S. Pharmacopœia Pepsin Assay: A. ZIMMERMAN.

Laboratory Studies of Pepsin, Pancreatin and Combinations of these Ferments: A. ZIMMERMAN.

Precipitated Sulphur, a Study of a Dermatological Prescription: EDW. KREMERS.

The Moisture Content of Drugs: EDW. KREMERS.

A Study of the Bromine and Iodometric Methods for the Determination of Resorcinol: C. M. PEIRCE.

The iodometric method is of little value. The bromine method gives good results only under certain conditions.

Too large an excess of KI causes some decomposition of tri-brom-resorcinol. Considerable dilution before addition of KI causes precipitate to dissolve, permits a rapid reversal of tri-brom-resorcinol brom and counteracts tendency for decomposition of tri-brom-resorcinol.

The bromine methods as recommended for determination of resorcinol in commercial resorcinol is briefly as follows: prepare a 500 c.c. aqueous volumetric solution containing 1.4563 g. resorcinol; withdraw 25 c.c. portions; dilute with 500 c.c. water; add 5 c.c. HCl and let set 1 minute; dilute with 200 c.c. water; add 5 c.c. KI 20 per cent. and let set 5 minutes; titrate liberated iodine with N/10 thiosulphate using starch as indicator. The number of cubic centimeters of N/10 Br consumed divided by .4 gives percentage of resorcinol.

Estimation of Morphine by Extraction with Phenyl-ethyl Alcohol: A. D. Thorburn, Indianapolis.

An aqueous solution containing morphine is made alkaline and shaken with a mixture of phenyl-ethyl alcohol and benzene; the solution of the alkaloid in phenyl-ethyl alcohol is then partially evaporated and titrated. The method is designed for quantities of sample representing less than .175 gm. anhydrous alkaloid and can be completed in about four hours.

The Relation of the Alkaloids of Gelsemium to One Another: L. E. Sayre.

The Volatile Acidity of Tragacanth and other Gums: W. O. Emery.

A Modified Form of Repercolation: E. G. Eberhardt, Indianapolis, Ind.

The author discussed the advantages of repercolation, gave results obtained on cimicifuga and gentian by triple percolation, as shown by extractive determinations made in successive fractions of percolate and describes a continuous or serial method of percolation giving results obtained in its use.

Tincture Cantharides: E. G. Eberhardt, Indianapolis, Ind.

The sparing solubility of cantharidin in alcohol makes a 10 per cent. alcoholic tincture impracticable. The author gives results obtained in various attempts to secure a full-strength tincture and gives two methods by which cantharides may be exhausted, one of these depending on the conversion of cantharidin into cantharidate, and extraction with dilute alcohol, but yielding a preparation which is but weakly irritant, the other depending on the liberation of combined cantharidin in the drug by an acid and extraction with acetone, yielding an actively vesicant preparation.

Notes on the Iodometric Determination of Strength of Formaldehyde Solutions: Joseph S. Chamberlain.

The Pharmacopœial Standard for Desiccated Thyroid Glands: Reid Hunt and Atherton Seidell.

The Manufacture and Testing of Drugs (illustrated): W. A. Pearson.

Acetate Collodion: Edward C. Worden.

Attention is called to the combustibility of the pharmacopœial pyroxylin, and to the inflammability of the official solvents directed to be used in the preparation of the collodions. The replacement of pyroxylin by cellulose acetate is advocated, and attention drawn to the use of acetate collodion in photography, where it has long since passed beyond the experimental stage. Uninflammable cellulose acetate combined with chloroform, carbon tetrachloride or tetrachlorethane, all of which fluids are unburnable, the author believes would result in the formation of transparent, clear, adhesive solutions, possessing all the desirable properties of the present pharmacopœial and National Formulary collodions, with entire absence of inflammability. A bibliography of 300 citations is appended.

Aromatic Spirits of Ammonia: Linwood A. Brown.

Rapid Determination of Beeswax and Honey: Fred Klein. (Read by Frank R. Eldred.)

The Accelerating Action of Hydrochloric Acid upon the Starch-converting Properties of Pancreatin and Malt: A. Zimmerman.

The Estimation of Minute Quantities of Nitroglycerine: Wilbur L. Scoville.

Nitroglycerine given medicinally in doses of 1/1000 to 1/20 grain. The material used a 10 per cent. alcoholic solution or a 20 per cent. powder mixture containing some carbonated alkali. Both materials variable in strength and somewhat unstable, and a loss also occurs in the process of manufacturing, so that an accurate and reliable method of estimation in mixtures is needed. The alkaline-titration method of no value. The nitrometer requires special skill for good results.

By the use of phenoldisulphonic acid colorimetrically, as in the estimation of nitrates in water, quantitites of 1/100 grain or less can be accurately estimated. The process is rapid and requires no special skill. It is particularly adapted to the estimation of nitroglycerine in tablets, pills, solutions, etc.

The Determination of Camphor in Spirits of Camphor: L. D. Havenhill.

A New and Accurate Method for Determining the Tryptic Value of Pancreatin: C. F. Ramsay.

The U. S. P. method for testing pancreatin on milk is indefinite and inaccurate because of the end reaction. By the use of rennin for determining when the milk has been peptonized, an accurate method for determining the tryptic value of pancreatin has been worked out.

Commercial samples of pancreatin are found to vary in strength from 1:120 to 1:1,750.

(*To be continued*)